FLIGHT

and The AIRCRAFT ENGINEER

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The Outlook

Oil—the Lord of the Battlefield

SO far, the forecasts that this would be a war of machines rather than of man-power have been verified. Germany over-ran Poland with machines, which the gallant Poles vainly tried to stop by means of man-power and (in the oldest sense of the word) horse-power. They failed, and no one is surprised at their failure. On the western front one hears of shells, bombs, machine guns, tanks, and of little else.

Practically all these weapons depend for their mobility on oil. Even the guns are mostly moved forward by motor tractors. No belligerent can continue to fight if its supply of oil runs short, for the oil is now the lord of the battlefield. That fact was fatal to the Polish resistance, but it gives great confidence to the Western Powers. Germany is believed to have started the war with large supplies of stored oil, but it is not believed for a moment that those supplies can stand a wartime rate of consumption for three or more years. Britain and France can continue to replenish their supplies from all over the world, unless the submarine should get a stranglehold on the traffic of the seas, and of this there is little prospect. The very opposite is happening, for the Royal Navy is fast establishing a stranglehold on the U-boats.

In any case, Germany can get no oil from overseas, for German seaborne commerce has ceased to exist. She must look for supplies on the Eurasian continent. There is one oilfield near Lvov in Poland, and another famous one in Roumania. The Russian agreement has cut her off from both of them. That must be a profound disappointment to the Germans, but one must assume that there was a *quid pro quo*. There is, indeed, the possibility of buying from the Russians, but they are almost certain to demand cash payments and Germany is as short of cash as she is of oil. One possibility is that if the war lasts long enough German experts may organise Russian industry in return for exports.

Limited Supplies

BROADLY speaking, the position appears to be that Germany can turn out something like three million tons of home-produced fuel per annum. Of this quantity it does not, according to the best authorities on the subject, seem likely that much more than about 25 per cent. is aviation fuel of suitable quality—rendered so by the addition of tetraethyl lead, for the manufacture of which Germany has a plant.

It seems fairly obvious that this quantity is not sufficient to enable Germany to prosecute a major war for any considerable length of time. For the past two or three years Germany has imported very large quantities of aviation spirit, but that supply is now stopped, and the existing stocks would probably not last more than six or eight months. When that stock is consumed it appears likely that Germany would be extremely short of fuel.

The comparative inactivity of the German *Luftwaffe* up to the present has puzzled many students of the war, and many guesses have been made as to the possible explanation. The presence in Poland of a large percentage of the German Air Force was at one time assumed to account for the comparative absence of German military machines, but it may well be that in view of the "peace offensive" Germany refrained of set purpose from extensive action in the West. There may, however, be another explanation.

It is just possible that Germany is husbanding her fuel supplies and is deliberately keeping most of her air force on the ground in order to save it for something really "worth while." The near future will probably show whether that is so or not. In the meantime it would be unwise to assume, as has been done in some quarters, that the German air force is inferior in quality of personnel and material to the British and French, whatever may be the position in the matter of sheer numbers.

HOMING: After a long night's flying a Vickers Wellington bomber approaches its aerodrome as the early sun tinges the clouds below. Soon the pilot will switch the blowers of his two Pegasus engines into low gear and descend.

What of the Airscrew?

DURING his very interesting lecture to the World Automotive Engineering Congress in San Francisco, a summary of the latter part of which we publish this week, Mr. F. R. Banks indulged in some extremely interesting speculations concerning the aero engine of the immediate future.

With the details of his arguments, and the general conclusions to which these led him, many will agree, although not all. But it does appear to us that Mr. Banks failed to take into account one aspect of the subject which may in the end limit the size of individual engines. We do not doubt for one moment that if aero engines of 5,000 b.h.p. are demanded, our engine firms will produce them. But the power delivered at the propeller-shaft has to be absorbed, and it is difficult to see how this is to be done when powers of the order of 5,000 b.h.p. are involved.

Already with the engines of 1,500 b.h.p. to 2,000 b.h.p. which are now being developed, the airscrew problem is a serious one. It will increase at a much more rapid rate with increases in engine power. It is not merely that specific airscrew weight (airscrew weight/h.p.) rises with increase in engine power. There is the question of tip speeds approaching the speed of sound. There is a limit to the reduction gear ratio that can be used, and even increasing the number of airscrew blades does not solve the problem—it merely postpones the ultimate limit a little.

To us it seems that these problems, and there are many others of a less fundamental character, may well prove so formidable that if air strategy demands more and more power, the only solution which can be expected quickly is to increase the number of power units rather than the size of individual units.

Tentative Lessons

THE war is only a month old, and it is yet too early to draw any definite conclusions about the tactical powers and limitations of aircraft. One can only count the straws and make a guess from them as to which way the wind is blowing. Fighters, of course, have their well-defined duties.

Army co-operation machines also have their obvious duties, which cannot be much varied. Those duties are short reconnaissance, and ground attack is seldom required from them. They have also been used according to plan.

Flight has always maintained that the bomber is essentially a long-range gun, though deep reconnaissance is also part of its duties. In Poland the German bombers started by attacking the Polish aerodromes and badly crippling the opposing air arm. Then they worked in conjunction with the mechanised troops, acting as a sort of horse artillery. After the air resistance of the Poles had become negligible, the German bombers proceeded to destroy defenceless cities, towns and villages.

On the Western Front the bombers on both sides have, so far, been kept fairly strictly to their proper duties of long-range bombardment and deep reconnaissance. There has been one attack on enemy ships in dock, two attacks (one by each side) on enemy ships at sea, both of which have been failures, and numerous flights by the R.A.F. over Germany without any frightfulness.

THE WAR in the AIR

R.A.F. Exploits by Sea and Land

A German anti-aircraft gun position being prepared. In the distance may be seen the range-finder.

THE most interesting and perhaps the most significant, although not necessarily the most important story of the week, was the attack by twenty German aircraft upon a squadron of the British Fleet in the North Sea about 150 miles off the Norwegian coast. The story was first told in the House of Commons on Wednesday, September 27th, by Mr. Churchill, First Lord of the Admiralty, but as further information has come to hand it would be better to try to put the whole thing down in order.

On Tuesday, September 26, a British submarine had been damaged. It was returning home and, as is usual, a squadron of the Fleet was sent out to escort it. The squadron included capital ships, an aircraft carrier, a cruiser and destroyers. The pace at which the squadron could move would naturally be governed by that of its lame duck. The weather was fine but cloudy. While the British squadron was proceeding on its way an attempt was made by twenty German aircraft to bomb the British ships. Some of these aircraft were flying boats, others were dive-bombers. Some of the German aircraft, doubtless including the flying-boats, dropped bombs from a height, all of which missed all of the British ships. The dive-bombers made an attack with clouds covering them for the first part of their dive. They were met by the anti-aircraft fire of the Fleet and none of their bombs hit any British ship. On the other hand one German flying-boat was shot down, another, according to Mr. Churchill, was reported to be badly damaged, and a third German aircraft came down in the sea; a destroyer was sent out to collect her, and the crew of four were brought in as prisoners.

Wireless Silence

The first information which the Admiralty received of this incident was from a German broadcast which claimed that a British aircraft carrier was destroyed and several hits were made on a battleship, while the German aeroplanes had not suffered any losses. The first report from the British Commander-in-Chief of the Home Fleet, Sir Charles Forbes, came in by wireless about a quarter of an hour later. The reason for delay in reporting was probably that British warships at sea do not use their wireless when they are in areas where the use of wireless would give away their whereabouts to the enemy. The Admiralty had not, in fact, regarded the incident as one of very great importance. It is, however, of considerable significance as it is the first reported incidence of dive-bombing having been used in war against ships on the move, and it has been a failure. The reports do not make it quite clear whether any of the dive-bombers were hit by the fire of the ships, as Mr. Churchill mentioned two flying-boats as having been damaged, while the third German machine which was picked up by the destroyer may have been either a flying-boat or a landplane. It is a matter for intense satisfaction that this first real encounter between British ships at sea and enemy aircraft has ended in a striking success for the British ships.

The German wireless afterwards asked the question: "Where is the Ark Royal?" The Ark Royal is safe and sound at her station.

Another German claim was that a British cruiser had been damaged in the Firth of Forth. The Admiralty replied that a German aircraft attempted to bomb a destroyer near May Island at 11.30 a.m. on Wednesday, September 27th, but failed to obtain a hit or do any damage. Obviously the German airmen are not experts at ship recognition. To experts the difference between a cruiser and a destroyer would be obvious.

The U-boat which is alleged to have torpedoed *H.M.S. Courageous* arrived in Wilhelmshaven on Thursday, September 28th, according to Reuter.

Grand-Admiral Raeder, Commander-in-Chief of the German Navy, decorated the captain with the Iron Cross (first class) and every other member of the crew with the Iron Cross (second class).

An interview with the captain was broadcast, in which he said:

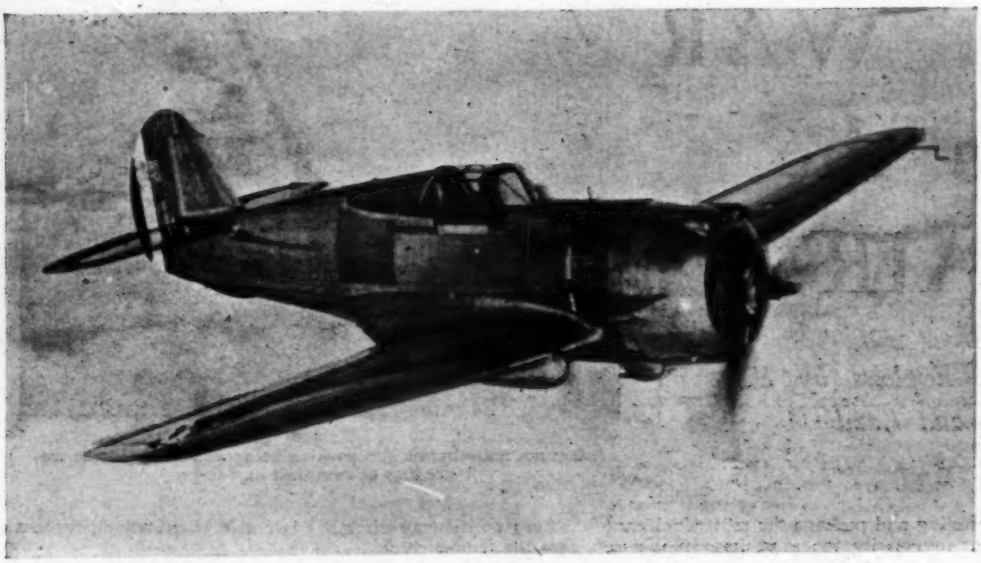
"We were to the south-west of Ireland. It was a beautiful Sunday afternoon, and we were looking for our 'Sunday joint.' At about 4 o'clock we saw the smoke of a British ship. We submerged immediately and waited. The British ship came nearer, but we were unable to fire.

"While we were waiting submerged we looked round for another ship, and suddenly I saw the smoke of an enemy warship. It was an aircraft carrier. Through my periscope I saw two aeroplanes flying round the ship and other escort vessels.

"Immediately I gave the order, 'Attack an enemy warship,' but we had to wait for an hour and a half till the *Courageous* came athwart our bows. Then the order was given, 'Torpedoes ready.' On seeing two destroyers making straight for the periscope I immediately gave the order to fire. Suddenly we heard several detonations and shouted for joy. The torpedoes must have found their mark.

"Then we heard the thrash of destroyers' propellers above our heads and the explosion of the first depth charges. The teacups fell from the table, the electric lights from their sockets, but nothing else happened. We dived deeper and waited for nightfall. Staying several hours under water we managed to escape the enemy warships. We had good luck and are very glad to be back at Wilhelmshaven."

On Monday, the 25th, the Royal Air Force sent another reconnaissance flight over Northern and Western Germany. They were attacked by fighters, but drove them off. That same night a further raid took place and leaflets were dropped. Some interesting details of the dropping of leaflets have been released by the Ministry of Information. Already some eighteen million leaflets have been distributed



over Germany. Though unspectacular in comparison with the magnificent attack on the heavily armed harbours in the Kiel area, these paper raids have been carried out under arduous flying conditions and with conspicuous success.

"Since the war began night flights have been made covering thousands of miles over enemy territory; some of the raids penetrated into Germany to a considerable depth.

"The pamphlets were loaded into the aircraft in bundles about the size of a heavy brick. A method for dropping the leaflets had been worked out. It was tested in a series of experiments, which proved that 'bricks' could be dropped and pamphlets released to fall on a particular area and thus reach the inhabitants of selected towns and cities.

"During the raids the aeroplanes flew at a great height. At a signal from the pilot the 'bricks' were released through the bomb hatches one after the other. The crews had to work at top speed. As the 'bricks' fell the pamphlets spread out in a paper shower.

"That most of them fell in the right places shows the high degree of navigational skill of the pilots in choosing during the hours of darkness the correct point at which to drop the bundles. Wind strength had to be gauged and calculations made on the basis of the previously ascertained rate of fall.

"On the night on which one of Germany's big industrial cities was paper-raided—which set the warning sirens screaming in Berlin—the 'bricks' were released more than 50 miles away from the town. By the time the wind and gravity had carried the pamphlets down to the streets our aircraft were well on their way home.

Reading "Verboten"

"The value of these paper raids has proved to be considerable. What the German High Command thinks of their moral effect is clear, for heavy penalties are imposed on persons seen picking up or reading the pamphlets. None the less, these pamphlets have given millions of people in various parts of Germany an opportunity to receive authoritative presentations of the Allies' case and of the reasons which have compelled them to take up arms.

"The flights have also been most useful from the point of view of reconnaissance."

Reports were received from Swiss sources which seemed to suggest that French aircraft were raiding Friedrichshafen, the old Zeppelin factory and also a factory for the manufacture of Dornier aircraft. The French, however, denied that any of their machines attacked Friedrichshafen, and now the opinion has been expressed in Geneva that sabotage had occurred there, and that possibly the old airship *Graf Zeppelin* had been destroyed.

German pilots seem not much more expert at recognising aircraft in the air than they are at recognising British ships at sea. On Tuesday, the 26th, a German seaplane attacked a K.L.M. commercial aeroplane—a Douglas D.C.3—piloted by the well-known pilot, J. J. Moll, who was one of the pilots of the Douglas machine which won second prize in the race from Mildenhall to Melbourne in 1934. There were nine passengers in the machine. The visibility was poor, but the Douglas was flying along calmly when suddenly the tail end of the passenger cabin was riddled with machine-gun bullets and a Swedish passenger was killed outright. Great admiration was felt for the calm action of the Dutch stewardess, for she pretended that the passenger who was hit had fainted and covered him with a blanket so that the other passengers were not aware of the tragedy until they arrived at Amsterdam, where Moll put his machine down safely on the aerodrome. The official German news agency has issued the following statement:—

"The Dutch aeroplane bore a likeness to a known type of enemy warplane, and could not be identified as a neutral machine by distinctive markings visible from a distance.

"Because of the weather conditions it was only possible to identify the 'plane's nationality from a short distance. The impression that it was an enemy aircraft was further increased by the fact that the 'plane apparently tried to escape into the clouds.

"As soon as doubt as to the machine's identity was removed the crew of the German seaplane immediately stopped firing. Although the incident is regrettable, the German crew cannot be blamed in view of the unfavourable weather conditions and the injudicious appearance and behaviour of the Dutch aeroplane."

The German Chargé d'Affaires called at the Swedish Foreign Office and expressed the regret of his Government at the death of the passenger, and Field Marshal Goering also expressed regret for the "tragic mistake" of the German seaplane. Naturally, considerable resentment has been felt in Holland, and it is pointed out that no belligerent countries are using Douglas aeroplanes, and that the word "Holland" has been painted in large letters in five different places on all K.L.M. machines. The K.L.M. authorities have, however, decided to paint a new prominent orange mark on all their machines.

On *Wednesday, Sept. 27th*, a British flying-boat alighted in the harbour of Raufarhoefn, Iceland, because of fog, and it was stated that the crew of nine were interned and that the captain of the aircraft gave his parole that he would not attempt to leave the country. However, the flying-boat has returned to this country, and a Service enquiry will be held into the circumstances of the incident. The Air Ministry authorises the statement: "With regard to the suggestion that the officers broke parole, the time-honoured traditions of the British Services with reference

French and British single-seater fighters. The picture on the left shows one of the Curtiss Hawk 75s of which France has ordered considerable numbers. The right-hand photograph shows two Hawker Hurricanes, one of which is just taking off.

to keeping of parole are well known. If it should be proved after the enquiry that parole has been broken, appropriate action will be taken."

A report has appeared in the papers that German aeroplanes tried to reach Scotland on Thursday, the 28th, but were driven off by fighters. This report was found to be without foundation.

We must now turn to the part played by aircraft in the land war, and they can only be made to fit into the picture by giving a glance, though only a superficial glance, at the general progress of hostilities.

In the east Warsaw has at last decided to capitulate, and, as its resistance has for several days past been of no material use to Poland, one can only feel relief that the terrible slaughter of the gallant defenders and of the helpless population has at last come to an end. For all practical purposes the campaign in Poland is now finished, although resistance continued still at one or two points. Accounts are coming through of the extreme barbarity of the Germans in their attack on this country. In many cases small towns and villages have been completely obliterated, sometimes by gun-fire, but chiefly by air bombing. In many of these cases there can have been no question of *franc tireurs* being at work. Where the destruction has been complete, the Germans, with cynical Teuton humour, have put up noticeboards on which has been written, "Here was such-and-such a town."

The belief is now becoming concrete that the understanding between the Russian and German Governments is very complete and very close, and probably this agreement was made even closer by the flying visit of Herr von Ribbentrop to Moscow. It looks as if Germany has agreed to give Russia a free hand in dealing with the Baltic States to the north and the Balkan States to the south. Russia has accused Estonia of harbouring enemy submarines, and has forced that Republic to sign an agreement which practically makes it a vassal state of the Soviets. At the same time, Rumania is showing great signs of nervousness, and is massing troops along her frontier. The Turkish Foreign Minister visited Moscow at the same time as Herr von Ribbentrop. We may feel pretty certain that Turkey would have no desire to see Russia mop up all the Balkan States and come within striking distance of that ancient object of her ambition, Constantinople, or, as it is now called, Istanbul. The position in that part of Europe may grow clearer before very long.

Turning to the Western Front, no great military movements have taken place. The French are advancing cautiously and endeavouring to get a grip on the industrial area of the Saar. If they can succeed in this, Germany will be deprived of one very important source of supplies.

The Germans have ordered the evacuation of Aachen (Aix la Chappelle) and are massing troops along the Dutch frontier. Holland and Belgium are certainly not feeling exactly tranquil, but in the main the operations on the west have taken the form of heavy artillery duels and continuous air activity. The French communiqués have at last alluded to the co-operation of the Royal Air Force with their own Armée de l'Air. Without any doubt the reconnaissance and photographing of German positions all along the front and behind the West Wall have been going on continuously, and General Gamelin and his staff must now have a very complete knowledge of German dispositions. The French and British bombers have continued to play the part of long-range artillery. That is the most useful work which bombers can do while a battle is in progress, and probably explains why, apart from our reconnaissance and leaflet-dropping raids, so few independent feats by our Air Force have been reported.

There have been numerous combats in the air.

Two Days' Fighting

It will be useful to quote in full the official history of two days' fighting which was published by the French Air Ministry on Thursday, September 28th:—

"The German general staff's assertions that most of the engagements between Allied and German aircraft have taken place over the French lines are categorically denied by the French Air Ministry.

"The German statement that 14 French pursuit 'planes have been shot down in the last two days is absolutely unfounded, and details of air fights that took place on Sept. 24 and 25 have now been released for publication.

"On Sept. 24 five French chaser 'planes engaged nine German Messerschmitt fighters in a desperate dog fight far beyond the front line. Two Messerschmitt machines were shot down and two others nose-dived, and French front-line infantry saw them hit the ground and catch fire.

"One French 'plane crashed in enemy territory and another fell over the French lines and was burnt out—it's pilot jumping by parachute and landing inside the French lines. He was able to report that a fifth Messerschmitt 'plane had fallen in flames near Laudau.

"The result of this air battle was five German machines lost to two French.

"On Sept. 25 there was another violent air battle above the German lines between three French Curtiss machines and five Messerschmitt fighters. Three German machines and one French were shot down.

"The remaining two German and two French machines continued the fight. One of the Germans was hit and made off, and the second German made off, apparently intact.

"Later another French machine was brought down by German anti-aircraft artillery, so that the scores were three Germans and two French brought down."

Some other items of interest concerning the war may be put on record. It has been stated that 14 British Blenheims have been flown to Rumania by Rumanian pilots.

New Zealand has promised to supply 1,300 pilots, observers and air gunners every year for the R.A.F. during the war, and perhaps exceed this number. There are at present in the United Kingdom 400 New Zealanders already pilots in the R.A.F., or undergoing training as such.

With regard to the statement that the rescue of the crew of the *Kensington Court* by British flying-boats was the first instance of its kind, a correspondent has written to *The Times* stating that on July 8, 1919, during the operations in north Russia, H.M. motor launch *Jolly Roger* was cruising alone on Lake Onega when her petrol tanks blew up without warning and she caught fire. The crew took to the water, but two British seaplanes arrived and alighted nearby followed by a third which, however, was damaged and could only taxy. These machines either conveyed or towed all the weak swimmers to the shore.

The Fate of the Fokker

A correspondent whom we believe to be usually very well informed sent us the following account of an incident on Saturday, Sept. 17th, namely the first occasion on which a German military aircraft attacked a Dutch machine: "A new twin-engined Fokker torpedo-bomber (Fokker T8-W) of the Dutch Navy under the command of a young lieutenant of the Dutch Royal Naval Reserve, and piloted by a Swedish pilot, was flying over the North Sea just out of the territorial waters in the neighbourhood of the Island of Ameland. It seems that the Dutch crew was a little curious about what was happening on the North Sea. They suddenly saw two German Dornier Do. 18 flying-boats approaching and, like good neutrals, returned. In the meantime, one of the German 'planes fired at the Dutch 'plane which was forced down and sank. The dashboard and one of its floats were shot to pieces. Two members of the crew, the commander and the pilot, were slightly injured. The two other men on board, a gunner and a N.C.O. were unhurt. One of the German Dorniers alighted on the sea owing to the failure of one of their Junkers Jumo engines, and floated into Dutch territorial waters, where the boat and its crew were interned. The Dutch crew were rescued by the crew of the other Dornier which alighted and the Germans took the heavily loaded machine to Nordeney, whence the four Dutchmen returned to Holland. The German authorities made excuses and offered a new aeroplane to the Dutch Navy. The German pilot stated that he and his men mistaking the Dutch machine for an English aircraft, immediately fired. Our correspondent adds that the Dutch marking in the future will be an orange circle surrounded by black, instead of the previous orange circle surrounded by red, white and blue.

The German submarines have now taken to sinking neutral vessels in the Baltic. Up to the present, eight vessels have been sunk by them—some Swedish and some Finnish. Indignation is growing in all the Scandinavian countries against this complete disregard of the rules of war.

Attacking a U-boat

Another case has been reported of a Royal Air Force machine, doubtless belonging to the Coastal Area, attacking a U-boat out in the Atlantic. The story is told in the following quotation from the pilot's log:—

"A very fine trail of oil was observed coming to the surface in a series of bubbly patches. The trail led due north. Sea markers were dropped, and the oil was seen to be moving slowly ahead of this point at two knots. After 15 minutes of careful observation bombs were dropped slightly ahead of and across the foremost oil patch. In the centre of a group of white circles made by the bombs a great quantity of oil suddenly gushed to the surface. A second attack was made along the oil trail and slightly ahead of it. In the centre of the new white patches of foam created by explosions oil again gushed up, this time for 30 minutes. No further movement of any sort was seen."

On Friday, *September 29*, machines of the Royal Air Force carried out attacks on ships of the German fleet in the Heligoland Bight. In spite of formidable anti-aircraft fire the attacks were pressed home at a low altitude. The Air Ministry added in its statement, "Some of our aircraft have not yet returned." The German version of the affair was that the attack was made by six British machines on German destroyers and that the attack was without result, while on their way back the British aircraft were engaged by German fighters, and in the course of a short battle five British machines were shot down into the sea.

On Saturday night yet another reconnaissance flight was made by the R.A.F. over northern Germany, and all our machines returned safely.

On the Western Front the Royal Air Force has been acquitting itself with great gallantry and determination. At the moment one of the most important functions which it can perform is to obtain complete information about the German defences and dispositions. A number of our reconnaissance machines adopted the plan of flying low at a height of only 600ft. over the West Wall for a number of miles, taking close-up photographs of gun emplacements, tank traps, types of camouflaging and the network of communication lines. They were not attacked by either gun-fire or by enemy fighters, and it seems that the German infantrymen mistook them for their own machines, as on occasions they stopped their work and waved greetings as the British machines flew overhead. Another flight had previously flown over the line at 21,000ft., but found their work hampered by heavy banks of cloud. They were, however, spotted by the German anti-aircraft guns and several shell bursts came uncomfortably near to them. But between the gaps in the clouds this flight managed to get photographs covering a huge expanse of country behind the West Wall.

A Gallant Fight

A particularly gallant effort at deeper reconnaissance was made by a formation of five British aircraft. They had been ordered to reconnoitre and doubtless photograph a particular position behind the German lines in the most strongly defended part of the Saar. They got through a fierce barrage from the anti-aircraft guns without damage, but when well over the frontier at a height of over 20,000ft. they were attacked by enemy fighters. First from behind a bank of cloud came nine Messerschmitts. They approached from straight ahead and 2,000ft. higher up than our machines. Another six attacked from our right flank. Our formation flew on. The Messerschmitts broke formation and concentrated their fire on each British machine in turn, coming up underneath the tails of the British aircraft. The fight lasted for thirty-five minutes. Three of our machines were shot down and another made a forced landing, but of the twelve men forming the crews of these machines eight were seen to escape by parachute.

The squadron leader was then left alone, but he flew on his reconnaissance course, dodging, side-slipping and banking, while his air-gunner kept up a steady fire from the rear guns. A stream of bullets struck the engine of the leading Messerschmitt, which swerved, burst into flames and plunged to earth. The gunner turned his attention to the next machine, and presently black smoke poured out from its nose. It, too, went down in a spin. The gunner had used 250 rounds of ammunition in accounting for these two Messerschmitts. The remaining German fighters then withdrew. The observer contrived to keep his pilot on the homeward course although his instruments were smashed and he himself had been grazed on the forehead by a bullet.

Our machine had eighty bullet holes in it, the ailerons and rudder were damaged, both petrol tanks were punctured and were flooding the inside of the fuselage with petrol and fumes. The engine just held out until the machine got across the frontier. The undercarriage jammed half-way up and the off-side tyre had been hit by bullets. Consequently, as the machine landed it spun round in a circle, cart-wheeled over on one wing and caught fire. The squadron leader was flung out clear and was picked up dazed but not seriously hurt. The navigator was flung out on his head with his clothes on fire, but on getting up he found that the gunner was jammed inside. The observer hauled him out and smothered his blazing coat with his bare hands. It was an extremely gallant fight against odds, and perhaps contains lessons for our high command.

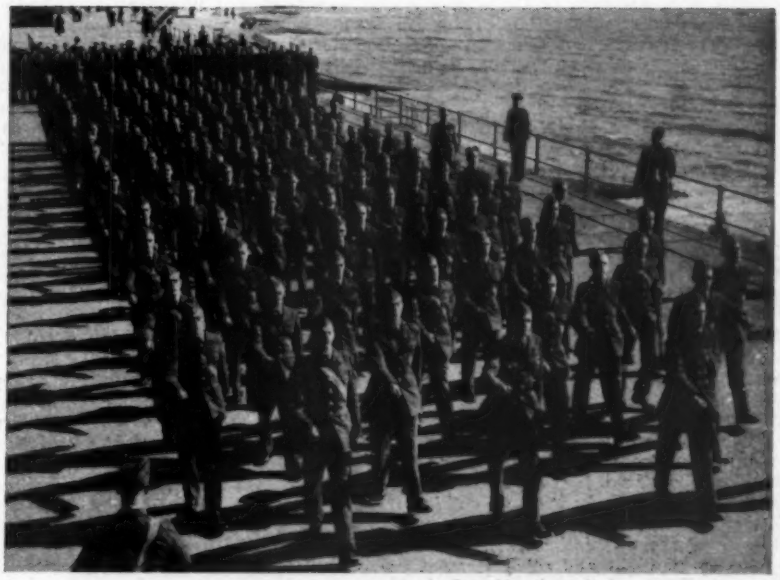
Over Berlin

On Monday, *October 2*, the Air Ministry announced that yet further reconnaissance flights had been made over Germany by long-range aircraft of the R.A.F., and they are described as having been successful. The most interesting point about the announcement is, however, that the flight, which was made by night, succeeded in getting over Berlin and Potsdam. This is the first time that our machines have reached the German capital, and it may be recalled that in the last war we never possessed any machines with sufficient range to get there and back. Now the good people of Berlin must know that their safety depends on British humanity, and not, as they thought, on British inability to reach them.

TRAINING the WARTIME AIR FORCE

Initial Training Wings

By MAJOR
F. A. de V. ROBERTSON, V.D.



IN the four years of the last war a huge expansion took place, from a modest beginning of four reconnaissance squadrons with a Central Flying School to a maximum of 8,000 trained pilots and 283,000 other personnel in 1918, while at the time of the Armistice there were no less than 20,000 other men undergoing flying training. In the months preceding the Armistice the average output of pilots was 1,200 a month.

Naturally, such an expansion, carried out in the stress of war conditions, was far from perfect in many respects, and until Col. Smith-Barry started the Gosport School of Special Flying the ideas on instruction were hazy. Men who could just fly an aeroplane, but had next to no instruction in what was required of a war pilot, were too often hurried off to squadrons at the front, and had to buy their experience there—if they lived long enough to make the purchase.

The R.A.F. is starting the present war in very different circumstances. The system of training for short-service officers and sergeant pilots which has been adopted since the expansion has been proved extremely sound. That system, as has often been described in these columns, consists of ten months, beginning at an Elementary and Reserve Flying Training School and ending at a regular R.A.F. Flying Training School. The elementary schools are managed by civil companies under Air Ministry direction, and they teach the pupil to fly an elementary type, and also give some ground instruction. At the regular F.T.S. the pupil is first put through a conversion course to teach him to fly Service types, and, finally, through an advanced course which instructs him in all that an R.A.F. pilot has to do when in a squadron. Observers are also put through special schools.

It would be difficult to improve on that system, and it is being retained now that war has come upon us, but the Air Ministry has added to it at the bottom. The new organisation consists of Initial Training Wings, to one of which all entrants for the classes of pilot and observer go before being passed on to an elementary flying school or other appropriate school. It is a pool, from which streams branch off in various directions. Men who have some experience, such as private pilots, are passed on more quickly.

Last Thursday I was permitted to visit one of these new I.T. Wings, which had only been in working order for ten days. But it is astonishing what progress can be made in ten days when one has the right type of instructor and

"An Alma Tadema might have painted the scene and called it 'Hellenic Warriors in Training.'" The scene referred to is the swimming bath, but the location may not be divulged. The only clue is that afforded by the picture at the top of the page, showing budding sergeant pilots "at the front."

a batch of young men of the right sort, all passionately eager to learn everything they can in the shortest possible time. The ages of the officers and sergeants under instruction range from 18 to 25, the average being about 19. The officers had entered before the present system had commenced, and were on probation. In due course the men from the R.A.F. Volunteer Reserve will all pass through one or other I.T.W., and no commissions will be awarded until a man has completed his course at a regular F.T.S., and proved his fitness to be an officer No permanent commissions are being granted during the war.

The I.T.W. which I saw is not yet located at an R.A.F. station, but is billeted in a town "somewhere in England." The men are living in very considerable comfort. There is no aerodrome, but there is no need for one, as the Link Trainer is the nearest that the men will get to flying before they pass on to an elementary flying school. They start off with physical training and barrack square drill. Both play their part in making them fit and smart. Considering that they had only been at it for ten days, the drill was most astonishingly smart. Every man behaved as if his one ambition in life was to prove that his squad could learn nothing from the Guards, and as if drill was the only thing in the world that mattered. Once men get that spirit, they will apply it to everything they have to do. They learn morse from qualified instructors, either past or present experts of the R.A.F., and they are lectured on theory of flight and other elementary subjects.

It was all very impressive, but I think what impressed me most was the type of young man which I saw. One is accustomed to seeing young officers on parade, but such very youthful sergeants seemed unusual. Both looked excellent material, quite first-class, intelligent and keen as mustard. At the swimming-pool it was possible to get a better idea of their physique, and again one was filled with admiration. An Alma Tadema might have painted the scene and called it "Hellenic Warriors in Training." If modern fighting consisted of a charge of hoplites with spear and shield, these young men would surely be able to rout the Persian Immortals. Instead, they have to fight with the weapons of science and brain, piloting complicated aeroplanes through the air, working out accurate courses, and allowing for speed and drift as they fire their machine-guns or drop their bombs on the enemy.

Beside the swimming-pool there stood a boxing ring, in charge of Sergt. Len Harvey, of whom the boxing world has heard. Pair after pair of men engaged in vigorous bouts, hitting as though their opponent was Adolf himself, yet all in the most perfect good temper. Sergt. Len Harvey was obviously very popular, and officers told me that he has a great gift for managing the men and winning their liking. Corpl. Eddie Phillips is also on the staff of the I.T.W.

This most gratifying state of affairs is what ten days has produced, but there are swarms more of young men as good as these waiting their turn to get into the R.A.F. Every day *Flight* gets letters from readers who want to know what chances they have of being accepted as pilots. The waiting may be galling for them, but their turn will come. Our Air Force is already the best in the world, and it will get larger and stronger as the war goes on. Already there are Dominions youths in this I.T.W. I was shown one group at the swimming-pool which consisted of two Canadians, two Australians, two South Africans, two New Zealanders, and two Englishmen, all diving together—and the diving was very high class. There are thousands more in all the Dominions straining at the leash, anxious as any man in Britain to get into the R.A.F. or to fight beside it in a Dominion squadron. The future of our Air Force, however long the war may last, is certainly secure.

The Royal Aero Club: Aviators' Certificates

No.	Name	Club or School	Date
19,983	Henry de Pinna Weil	London Air Park F.C. ...	31.8.39
19,984	Henry West	Witney and Oxford Ae. C.	31.8.39
19,985	Margaret Teale	Wiltshire Flying Club ...	31.8.39
19,986	Frederick George Fowler ...	Wiltshire Flying Club ...	31.8.39
19,987	Arthur Herbert Eastment ...	Wiltshire Flying Club ...	31.8.39
19,988	Bernard Kennaugh Thompson ..	Northern Aviation Club...	31.8.39
19,989	Herbert Richardson	Northern Aviation Club...	31.8.39
19,990	Wilfred Barker	North Staffs Aero Club ...	31.8.39
19,991	Alfred Leslie Jones	North Staffs Aero Club ...	31.8.39
19,992	Edward Desmond Cecil Cooper..	Cinque Ports Flying Club	31.8.39
19,993	Joseph Bernard Appleyard ...	York and Leeming F.C....	31.8.39
19,994	William Alan Charles Bond ...	Ipswich Aero Club ...	31.8.39
19,995	Hubert James Valentine Knight Stevenson	Ipswich Aero Club ...	31.8.39
19,996	Henry Arthur Green	Thanet Aero Club ...	31.8.39
19,997	Laurence Harvey Taylor... ...	Thanet Aero Club ...	31.8.39
19,998	William Norman Bennett ...	Thanet Aero Club ...	31.8.39
19,999	William George Andrews ...	Airwork Flying Club ...	31.8.39
20,000	Donald Sutherland	Airwork Flying Club ...	31.8.39
20,001	John Trevor Julian	Airwork Flying Club ...	31.8.39
20,002	Arthur Birkett	London Aeroplane Club...	31.8.39
20,003	William Roland Bradford ...	London Aeroplane Club...	31.8.39
20,004	Huia Masters Pickard	London Aeroplane Club...	31.8.39
20,005	Geoffrey Norman Bargate ...	London Air Park F.C. ...	31.8.39
20,006	Herbert Joseph Davis	Southend Flying Club ...	31.8.39
20,007	Philip Dunbar Brooks	Southend Flying Club ...	31.8.39
20,008	Charles William Goodsell ...	Southend Flying Club ...	31.8.39
20,009	Leslie Bernard Holmes	Southend Flying Club ...	31.8.39
20,010	Eric Linton Meiklejohn	Scottish Flying Club ...	1.9.39
20,011	Kenneth Savill	Eastbourne Flying Club...	1.9.39
20,012	Edward Arthur Stanley Parris ...	Eastbourne Flying Club...	1.9.39
20,013	James Anderson Bruce	Strathtay Aero Club ...	1.9.39
20,014	Charles Grant	Strathtay Aero Club ...	1.9.39
20,015	John Joseph Eric Walker ...	Herts and Essex Aero Club	1.9.39
20,016	Ronald Cedric de Wilde	Herts and Essex Aero Club	1.9.39
20,017	James Jeffrey Blake	Herts and Essex Aero Club	1.9.39
20,018	John Frederick Solomon Mitchell	Lancashire Aero Club ...	1.9.39
20,019	Claude Evelyn Fanner	Isle of Wight Flying Club	1.9.39
20,020	John Bennett Underwood ...	Malling Aero Club ...	1.9.39
20,021	Edmund Basil Higham Wright ...	London Air Park F.C. ...	1.9.39
20,022	Osmond Ivor Drake	Cardiff Aeroplane Club ...	1.9.39
20,023	Reginald William Stevens ...	Romford Flying Club ...	1.9.39
20,024	John Evelyn Pasmore	Luton Flying Club ...	1.9.39
20,025	Eva May Hicks	Yapton Aero Club ...	1.9.39
20,026	Donald William Linter	Yapton Aero Club ...	1.9.39
20,027	Stewart Boyes	Portsmouth Aero Club ...	1.9.39
20,028	Roy Swinton Kenyon	Northern Aviation Club...	1.9.39
20,029	Alec Richard Glover	York and Leeming F.C....	1.9.39
20,030	Dennis James McCutcheon ...	Yorkshire Aeroplane Club	1.9.39
20,031	William Wilfred Lyle	London Aeroplane Club...	1.9.39
20,032	Alastair Ninian Scott Johnston ...	London Aeroplane Club...	1.9.39
20,033	Linton Harry Durham	London Aeroplane Club...	1.9.39
20,034	Robert Edward Digby Cayley ...	London Aeroplane Club...	1.9.39
20,035	Eileen Isobel Atkinson	North of Ireland Aero Club	1.9.39
20,036	Mary Violet Lawton Gregorowski	Thanet Aero Club ...	2.9.39
20,037	John Alan Newstead	Ipswich Aero Club ...	2.9.39
20,038	John Stanley Smith	Ipswich Aero Club ...	2.9.39
20,039	Ronald Sidney Taylor	York and Leeming F.C....	2.9.39
20,040	Charles William Jarratt	London Air Park F.C. ...	2.9.39
20,041	George Richard Virgo	London Air Park F.C. ...	2.9.39
20,042	James Winnard	Bristol and Wessex Ae. C.	2.9.39
20,043	Frank Alfred Prevett	Cinque Ports Flying Club	2.9.39
20,044	Reginald Herbert Smith	South Coast Flying Club...	2.9.39
20,045	Alfred John Hamlin	South Coast Flying Club...	2.9.39
20,046	Albert Edward Christian York Bramble	South Coast Flying Club...	2.9.39
20,047	Charles Leo Carter	Northern Aviation Club...	2.9.39
20,048	John Lomax Higham	Lancashire Aero Club ...	4.9.39
20,049	Arthur Stanley Alcock	Lancashire Aero Club ...	4.9.39
20,050	Raymond Herbert Kenyon ...	Lancashire Aero Club ...	4.9.39
20,051	Simon Pearson Lambert	York and Leeming F.C....	4.9.39
20,052	Ronald Belbin	Wiltshire Flying Club ...	4.9.39
20,053	Henry James Pea	Worcestershire Flying Club	4.9.39
20,054	Frederick William Chapman ...	Worcestershire Flying Club	4.9.39
20,055	Barbara Winifred Sharp	London Aeroplane Club...	4.9.39
20,056	William Alfred Edmonds... ...	London Air Park F.C. ...	4.9.39
20,057	Arthur John James Chell ...	South Staffs Aero Club ...	4.9.39
20,058	Frederick John Clyne	Reading Aero Club ...	4.9.39
20,059	Bryant Frank Talbutt	Lincolnshire Aero Club ...	4.9.39
20,060	George Ernest Sapcote	Lincolnshire Aero Club ...	4.9.39
20,061	Charles Brown King	Lincolnshire Aero Club ...	4.9.39
20,062	John Cecil King	Hull Aero Club	4.9.39
20,063	Terence George Robins	Hull Aero Club	4.9.39
20,064	William Beedham	Hull Aero Club	4.9.39
20,065	John Taylor	Hull Aero Club	4.9.39
20,066	William Benson Owst	Hull Aero Club	4.9.39
20,067	Eric Austin Livingstone	Hull Aero Club	4.9.39
20,068	James Edmund Jameson ...	Kent Flying Club ...	4.9.39
20,069	Frank George Manning	Kent Flying Club ...	4.9.39
20,070	Bernard Frederick Groundsell ...	Isle of Wight Flying Club	5.9.39
20,071	Ferdinand Christian Rammelt ...	London Air Park F.C. ...	5.9.39
20,072	Horace Edward Cheeseman ...	Midland Bank Flying Club (Horton Kirby) ...	5.9.39
20,073	Cecil Gordon Houghton	Northern Aviation Club...	5.9.39
20,074	Donald George Weil	Yorkshire Aeroplane Club	5.9.39
20,075	Lawrence Thomas Harty ...	Yapton Aero Club ...	5.9.39
20,076	Thomas Andrew Stewart ...	Wiltshire Flying Club ...	5.9.39
20,077	Harold William Sefton	Wiltshire Flying Club ...	5.9.39
20,078	Francis Arthur Parkhouse ...	Exeter Aero Club ...	5.9.39
20,079	Archie Pearson Blackie	Exeter Aero Club ...	5.9.39
20,080	George Clifford Dixon	Hull Aero Club	5.9.39
20,081	James Albert Gledhill	Hull Aero Club	5.9.39
20,082	Hugh Francis Holme	Wiltshire Flying Club ...	6.9.39
20,083	Gregory Owen John Melitus ...	Brooklands Flying Club...	6.9.39
20,084	John Alexander Duncan Lawson	Brooklands Flying Club...	6.9.39
20,085	Thomas Maxwell Hudson ...	Brooklands Flying Club..	6.9.39
20,086	Michael Lanyon Roe Thompson...	Brooklands Flying Club...	6.9.39
20,087	John Herbert Reginald Edwards	South Coast Flying Club..	6.9.39
20,088	Howard Thomas Skett	Midland Aero Club ...	6.9.39
20,089	Jennefer Jude	Midland Aero Club ...	6.9.39
20,090	Walter Blades	Midland Aero Club ...	6.9.39
20,091	James Owen	Midland Aero Club ...	6.9.39
20,092	William Lonsdale Parkinson ...	Lancashire Aero Club ...	6.9.39
20,093	Anthony John Deane-Drummond	Wiltshire Flying Club ...	6.9.39

A Messerschmitt Bf 109 single-seater of the earlier series, powered with a Junkers Jumo 210 inverted vee-twelve of 640 h.p

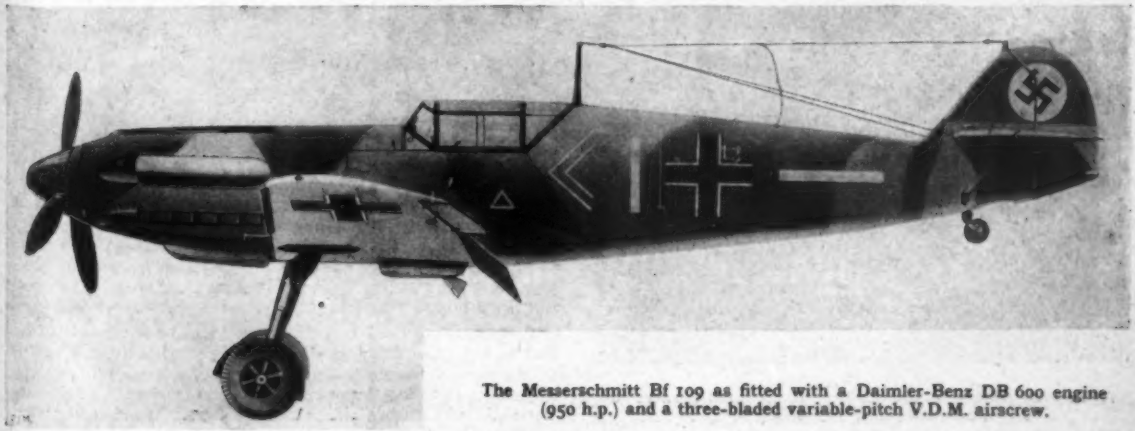
FIGHTERS of the LUFTWAFFE

Heinkels and Messerschmitts Described : Facts About the Record-breakers

By H. F. KING

FIGHTER squadrons of the *Luftwaffe* were initially equipped with Heinkel and Arado single-seater biplanes which, fitted with naturally aspirated B.M.W. VI engines, had an unspectacular performance. For some time there was much conjecture as to the machines which would be selected from a number of prototypes then on test to replace these obsolescent models. It was at the Zurich International Meeting in July, 1937, that the world was first introduced to the chosen successors, which had not long since been wheeled from the rapidly growing Messerschmitt and Heinkel factories. Both types displayed unique features of aerodynamic and structural design and were designated the Me (or Bf) 109 and the Heinkel He 112. They gave an indication of their performance in a number of competitive events, the Messerschmitt being particularly successful. An Me 109 flown by Major Seidemann won the Alpine Circuit race at an average speed of 240.9 m.p.h. (this, of course, did not represent anything like top speed) and another, flown by Karl Francke, climbed to 9,842ft. and dived back to 984ft. in 2 min. 6 sec.

After their début the two fighters underwent a period of development and had their share of teething troubles with the result that the types which were eventually standardised for squadron use differed in a number of respects from the prototypes. The largest orders were placed for the Messerschmitt, fitted in the first place with a Junkers Jumo 210 engine of only 650 h.p., though later series were fitted with the Daimler-Benz DB 600 unit rated at 950 h.p.



The Messerschmitt Bf 109 as fitted with a Daimler-Benz DB 600 engine (950 h.p.) and a three-bladed variable-pitch V.D.M. airscrew.

A post-delivery line-up of some of the lower-powered Me 109s. It will be seen that some have wooden airscrews and others metal.

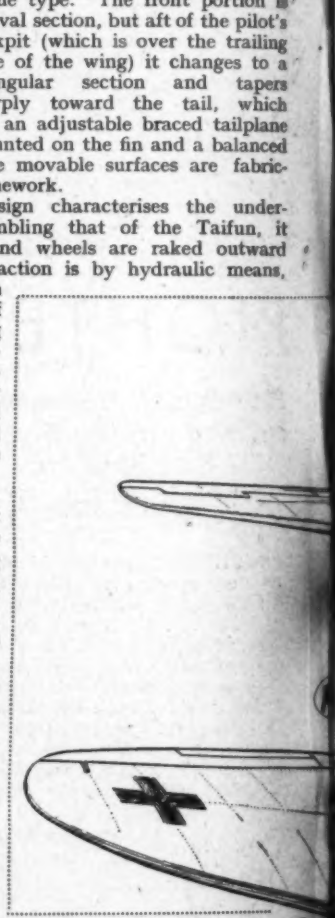
The Messerschmitt Me 109 was designed by Professor Willy Messerschmitt and is built by the B.F.W. concern (Bayerische Flugzeugwerke A.G.) which explains why the type is sometimes called the Bf 109. It bears a remarkable resemblance to the Me 108 (Taifun) civil four-seater which is renowned for its speed range and all round excellence of control (see *Flight*, June 29, 1939).

A Bf 109 zooms dramatically. Exceptional powers of manœuvre are claimed for this machine.

The trapezoidal low cantilever wing tapers straight toward square-cut tips. It is entirely of duralumin construction with countersunk riveting. Each half is bolted directly to the fuselage. The entire trailing edge is hinged, the inner sections functioning as flaps and the outer portions as ailerons, and Handley Page automatic slots are fitted over a considerable portion of the leading edge.

Fuselage construction is of a straightforward duralumin monocoque type. The front portion is of oval section, but aft of the pilot's cockpit (which is over the trailing edge of the wing) it changes to a triangular section and tapers sharply toward the tail, which has an adjustable braced tailplane mounted on the fin and a balanced rudder and elevator. The movable surfaces are fabric-covered, with a metal framework.

Simple but curious design characterises the undercarriage. Although resembling that of the Taifun, it differs in that the legs and wheels are raked outward instead of inward. Retraction is by hydraulic means, the wheels being housed in wells in the lower surface of the wing. Small fairing panels inboard of, and retracting with, the compression legs and wheels, cover the troughs for the legs and large segments of the wheel wells when the undercarriage is raised.



The pilot's enclosed cockpit has a generous amount of transparent panelling; the roof opens transversely instead of sliding fore and aft. Beneath the side panels of the windscreen are small supplementary windows which improve vision in a forward and downward direction. Two-way wireless is housed to the rear of the cockpit and the machine is equipped for night flying.

The first batches of Me 109s delivered to the *Luftwaffe* are believed to have been fitted with the Junkers Jumo 210G engine driving a two-bladed airscrew, either a variable-pitch V.D.M. or a fixed-pitch wooden type. The two-bladed airscrew, incidentally, is a characteristic of the lower-powered Me 109, the later versions with Daimler-Benz DB 600 engine having a three-bladed variable-pitch V.D.M. When the Junkers engine is fitted the radiator is beneath the engine cowling just forward of the wing, but when a Daimler-Benz is installed radiators are fitted under the wings in addition to that under the fuselage. Due to the shape of the crankcase of the Junkers and Daimler-Benz engines cowling lines are hardly as smooth as those of our Spitfire and Hurricane.

Armament of the Me 109 is believed to vary considerably, but in any case, there are twin synchronised machine guns in the top of the cowling. Two additional machine guns, or shell-guns, can be mounted in the wings. These are normally of German rifle calibre (0.311in.). It is reported

The most detailed view ever published of the Messerschmitt Bf 109R which, flown by Fritz Wendel, attained a speed of 755.138 km/hr. (469.225 m.p.h.). A special DB 601A engine giving something like 1,800 h.p. was installed. The cruciform tail is notable.

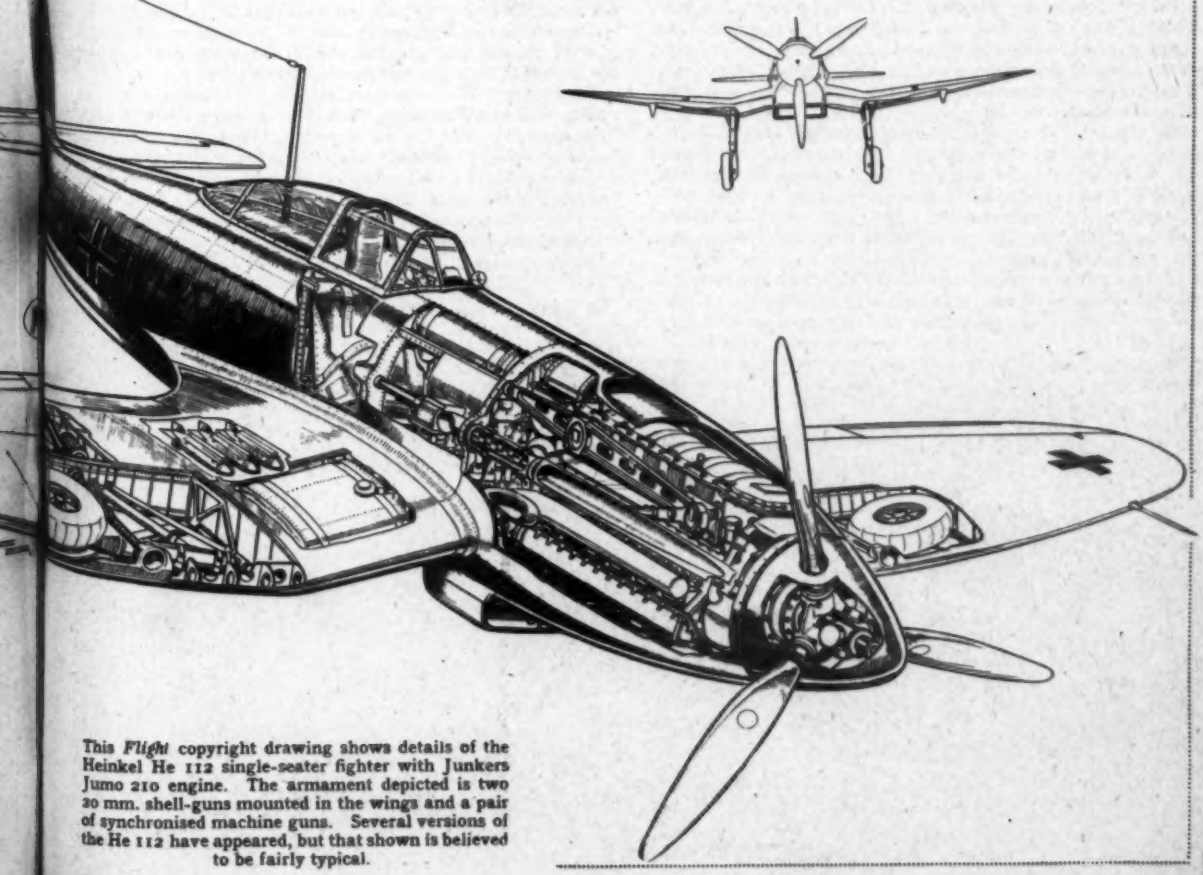
that Daimler-Benz-powered Me 109s used in Spain were fitted with two 23 mm. wing-mounted shell-guns. Incidentally, the hole in the nose of the V.D.M. spinner does not necessarily denote that a shell-gun is fitted to fire through the airscrew hub.

There can be no doubt that the Me 109 is a delightful machine to fly. "Al" Williams, who was permitted to "play" with one in Germany, waxes lyrical about its handling qualities though he gives no indication of precise performance. The following figures, however, are believed to be reliable. When fitted with the Jumo 210 engine the top speed, attained at 13,100ft., is only 285 m.p.h. The climb to 16,400ft. takes 6 min. 8 sec. and the ceiling is 26,541ft. and the range 340 miles. When the Daimler-Benz DB 600 is used the top speed goes up to 323 m.p.h. and the climb to 16,400ft. takes a fraction over 5 minutes. A ceiling of 36,489ft. is claimed and the range is given as 445 miles, presumably at full throttle. An engine of the Daimler-Benz DB 601 series, which is now standardised in the *Luftwaffe*, should give an appreciably higher performance.

Some exceptionally high speeds have been put up by specially prepared versions of this fighter. On November 11, 1937, J. H. Wurster attained 379.59 m.p.h. on a machine which was termed the Me 113R. Fundamentally this resembled the Me 109; the wing area was quite expansive and there was a large radiator below the starboard wing. On April 26 this year Fritz Wendel reached 469.225 m.p.h. in what was officially described as an Me 109R. This figure now stands as the world's absolute speed record. In comparison with the earlier type of Messerschmitt record-breaker, the Me 109R (the works number 109 was probably used for the express intention of conveying the impression that the machine was similar to the standard fighter) had much less wing area, a wing of different section and plan form, a redesigned fuselage, a new cockpit enclosure, and a striking cruciform tail reminiscent of those on the old Macchi racing seaplanes. Moreover it was powered with a very much boosted Daimler-Benz DB 601A, said to deliver 1,800 h.p. at 3,500 r.p.m. against the 1,150 h.p. at 2,400 r.p.m. of a typical DB 601 of series production.

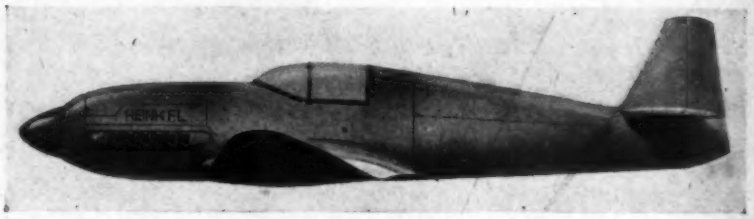
Messerschmitt Me 109 fighters have been extensively used

A GERMAN FIGHTER IN DETAIL



This *Flight* copyright drawing shows details of the Heinkel He 112 single-seater fighter with Junkers Jumo 210 engine. The armament depicted is two 20 mm. shell-guns mounted in the wings and a pair of synchronised machine guns. Several versions of the He 112 have appeared, but that shown is believed to be fairly typical.

The latest version of the He 112U which, although claimed to be in production for squadrons of the *Luftwaffe*, is very similar to the He 112U record-breaker shown below. Showing the lines of the special He 112U, which attained a speed of nearly 464 m.p.h. The characteristics of the machine are shown here, though information on cooling is still lacking.



both on the Eastern and Western Fronts and as this article is written news comes that eight have been shot down in a fight with Allied fighters, including Curtiss P.36s.

In appearance the Heinkel He 112 single-seater fighter, which is the subject of the Max Millar drawing on these pages, is one of the most business-like machines imaginable. It is of small size (span 30ft. 2in., length 29ft. 6in.), and is generally considered to be rather more of a "handful" than the Messerschmitt.

In the form in which it first appeared at the Zurich Meeting it had an open cockpit, but has since been turned out with two or three different types of cockpit enclosure, a variety of engine installations and other modifications. Naturally, the record-breaking He 112U, to which detailed reference will later be made, differs very extensively from the original design.

The cantilever monoplane of the He 112 is of characteristic Heinkel form. The centre-section has a pronounced anhedral angle giving an "inverted gull" effect; the outer panels are of elliptical form and taper sharply in thickness. There are two spars and the covering is smooth metal. Unlike the Messerschmitt, which has camber-changing flaps, the Heinkel has split flaps.

The Heinkel's fuselage is a metal monocoque structure of oval section and the tail unit is completely cantilever, the movable surfaces having trimming tabs.

The retractable undercarriage is attached where the centre section of the wing meets the outer panels and folds in an upward and outward direction, the wheels and struts being completely covered when the gear is up. As in the Messerschmitt the pilot's cockpit corresponds with the trailing edge of the wing, but due to its design and the greater amount of transparency toward the rear the pilot has a better backward view.

As in the case of the Messerschmitt, all the earlier He 112s

A pastoral scene with a background of Heinkel He 112 fighters.

The Messerschmitt Me 110 twin-engined fighter and multi-purpose machine with Daimler-Benz DB 601 engines.

were fitted with the Junkers Jumo 210. The high wing loading made the fitting of a v.p. airscrew imperative even in the earlier models. The radiator is fitted beneath the engine cowling as on the Messerschmitt, and fuel is carried in the inboard portions of the wing.

Armament, of course, can be varied, but our drawing shows two synchronised rifle-calibre machine guns installed in the fuselage and a pair of shell-guns in the wing. The version offered for export could carry six fragmentation bombs of about 22 lb. each.

The following figures were issued by the manufacturers. It is believed that those for the version with the Daimler Benz engine (wing loading about 31 lb./sq. ft.) are published in this country for the first time.

	Jumo 210G	Daimler Benz 601A
Maximum power	670 h.p.	1,070 h.p.
Rated altitude	13,100	12,150
Weight empty	3,571 lb.	4,188 lb.
All-up weight	4,960 lb.	5,620 lb.
Speed near ground	267 m.p.h.	285 m.p.h.
Top speed	317 m.p.h.	354 m.p.h.
Height for top speed ..	15,420ft.	14,760ft.
Climb to 6,560ft.	2.6 min.	2.5 min.
Climb to 13,120ft.	6 min.	5 min.
Climb to 19,680ft.	9.5 min.	7.5 min.
Service ceiling	31,000ft.	31,000ft.
Landing run	350 yd.	415 yd.

It would appear on the face of things that the He 112 would make a better potential record-breaker than the Messerschmitt as its lines approach aerodynamic perfection. Certainly developments of the He 112 have reached amazing speeds, the fastest being 463.95 m.p.h.; but as we have stated, the Messerschmitt did over 469 m.p.h. This figure stood as the world's record before Wendel's effort, and was attained by Heinkel's test pilot, Hans Dieterle, on March 30 this year.

Apparently the designation He 112U is applied both to the record-breaker and to a single-seater fighter which to all outward appearances is very similar to it and which, according to the manufacturers, is in series production for the *Luftwaffe*.

The only detailed photograph of the fighter version appeared in *Flight* of April 20, 1939. This was taken from a news-reel film made at the time of Dieterle's record, and showed Dieterle leaving his machine after what was supposed to be the record-breaking flight. Actually this could not have been the case, as the aircraft shown was fitted with a wireless aerial and carried service markings. On the other hand, it is to be questioned if the machine depicted was a fighter off the production line, as the word "Heinkel" appeared in large letters on the engine cowling.

The He 112U fighter has a different fuselage and tail from the earlier type already described, and the cockpit enclosure is built into the fuselage rather than being installed as a unit on top. Rearward vision has accordingly been sacrificed. The wing appears to be much the same, though it may be of reduced area and of modified section, but the undercarriage is of wider track and greater height and retracts inwardly. The engine is a Daimler Benz 601A driving a three-bladed constant-speed V.D.M. airscrew. Performance is probably improved slightly by the rearward-facing exhaust stubs, which are faired at back and front.

The windscreen of the record-breaker is longer than that of the fighter to give better entry, and is moulded in one piece, whereas that of the military machine has an optically perfect flat panel to permit the best use to be made of the reflector gun sight. No gun troughs appear in the fuselage of the fighter, though there can be precious little room left in the wing for armament in view of the size of the undercarriage.

Messerschmitt Me 110

Like the other Powers, Germany has developed twin-engined fighters, the standard type being the Messerschmitt 110 two-seater. A machine of this type was demonstrated at Nuremberg in September, 1938, and since that time has been issued in quantity to squadrons of the *Luftwaffe*. At least one squadron took part in the fly-past in June this year in honour of Prince Paul, Regent of Jugoslavia. Little information is available on the new Messerschmitt, but the machine is depicted on this page. The prototype was equipped with two Daimler-Benz DB 601 engines with two-speed superchargers. Each of these units, according to a French source, delivered a maximum of 1,360 h.p. and gave a top speed of 379 m.p.h. at 16,400ft. Possibly some of the production machines have been powered with Junkers Jumo 211s.

The armament of the Me 110 is two fixed shell-guns (20 or 23 mm.) and four machine guns, which may be of heavier calibre than is normally fitted.

It may be assumed that the range of the Me 110 is considerably longer than that attainable by the single-engined fighters, and the machine is accordingly suitable for escort work. In addition, it can be used for light bombing, ground attack or reconnaissance, or may function as a "fighter-command" type or what the French call (*commandement à la chasse*).

It is known that the Focke-Wulf concern produced a fighter prototype which also appeared at Nuremburg last year. This machine had a pusher propeller, but other details are lacking. It is not thought that the type has been ordered for series production.

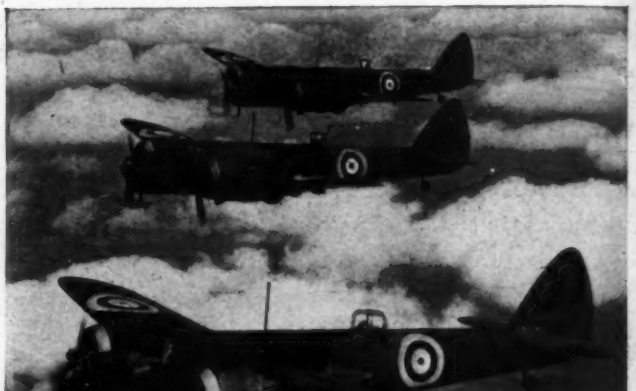
U-Boats Notwithstanding

UNSUNG, and almost unknown, the experimental flights across the Atlantic scheduled by Imperial Airways months ago have continued, and not until it was announced that *Cabot* had made a record flight the other day from Ireland to Newfoundland in 13 hours 2 minutes was the general public permitted to know that these flights are taking place.

Incidentally, it may be assumed that the crews of the Short flying boats have had navigational problems set them which were not originally contemplated. Obviously the assistance from shipping, in the way of giving positions, has not been forthcoming, and navigation has had to be entirely by the means carried on board the flying boats.

SERVICE AVIATION

Royal Air Force and Official Announcements : Fleet Air Arm News



"*Flight*" photograph.

MULTI-PURPOSE : The Bristol Blenheim, although chiefly famed as a bomber, is adaptable as a strategical reconnaissance machine or fighter. Vast quantities have been delivered to the Royal Air Force. The machines seen are of the Mark IV, or "long-nosed" variety. They have Bristol Mercury VIII engines.

Canadian Lysanders and Sharks

THE first Westland Lysander II army co-operation machine built for the Royal Canadian Air Force at the Malton works of the National Steel Car Company, Ltd., has passed manufacturers' tests, the initial flight being made by Mr. Leigh Capreol, a Montreal test pilot. Engines of the Canadian Lysanders—Bristol Perseus XII sleeve-valve units giving a maximum output of 905 h.p. at 6,500ft.—are supplied by British Aeroplane Engines, Ltd., of Montreal.

News has also been received that the first of a group of Blackburn Sharks has been completed by Boeing Aircraft of Canada and handed over to the Canadian Department of National Defence. These machines are fitted with Bristol Pegasus engines and have interchangeable wheel and float undercarriages.

A GOOD PLAN : The plan view of a draughtsman's general-arrangement drawing could be little more accurate than this *Flight* photograph of a Fairey Battle single-engined bomber (Rolls-Royce Merlin engine). The Battle was the subject of one of the first "Expansion" orders and is doing excellent service. It is extensively used as a dive-bomber.

Entertaining the Service

FORMED two years ago for the purpose of supplying R.A.F. stations in isolated positions with cinema shows once, twice or three times a week, C.B. Projections, of Guildford, has just put a new fleet of their specially constructed mobile units into service. These vans cover about ten or twelve thousand miles a week in this country and a number of units are being prepared for service overseas. During the last month the fleet has been more than trebled.

Within half an hour of arriving in anything from a power shed to a cinema the units can be in operation; two shows, lasting about two or two and a half hours each, are given each evening.

Second Casualty List

THE Air Ministry announce the following casualties on various dates:—

KILLED.—P/O. D. S. M. Burrell, P/O. M. L. Hulton-Harrop, A/C. 2nd class W. A. O'Brien.

REPORTED MISSING (BELIEVED KILLED).—Sgt. D. E. Jarvis.

MISSING.—Flt. Sgt. I. E. M. Borley, P/O. G. W. Brant, A/C. 1st class S. A. Burry, Sgt. R. C. Grossie, A/C. 2nd class R. Henderson, Sgt. A. O. Heslop, Sgt. C. A. Hill, Sgt. O. L. D. Howells, F/O. H. P. Lightoller, Sgt. G. Miller, A/C. 2nd class J. Murphy, P/O. W. J. Murphy, Sqn. Ldr. S. S. Murray, Sgt. S. G. McK. Otty, A/C. 1st class P. F. Pacey, Cpl. G. W. Park, A/C. 2nd class E. Pateman, P/O. A. B. Thompson, Flt. Sgt. A. J. Turner, Sgt. L. R. Ward.

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Royal Air Force

General Duties Branch

Group Capt. the Hon. R. A. Cochrane, C.B.E., A.F.C., is appointed Air Aide-de-Camp to the King (September 1), in the vacancy created by the promotion to air rank of Air Comdre. J. C. Slessor, D.S.O., M.C.; Flt. Lt. J. W. McGuire, A.F.C., is granted a permanent commission in that rank (August 14); P/O. J. J. Bennett is promoted to the rank of Flying Officer (February 6) (substituted for notification in *Gazette* of June 16); P/O. W. T. Brooks is granted the acting rank of Flight Lieutenant from August 8 to 31 inclusive; F/O. P. H. R. R. Terry resigns his short-service commission (September 15) (substituted for notification in *Gazette* of September 12); Air Comdre. C. C. Darley, C.B.E., A.M., is placed on the retired list on account of ill-health (September 14).

The notification in the *Gazette* of September 19 concerning the following is cancelled:—Flt. Lt. P. Ruston, F/O.s A. W. Fletcher, D. H. C. Hull, A. E. Pringle, H. W. A. Sheahan.

Equipment Branch

The following Flying Officers on probation are confirmed in their appointments (September 12):—J. Connell, A. W. Edwards, H. Hawkins, E. M. Maurice, J. P. Scorgie, R. W. Woodley.

The following Pilot Officers on probation are confirmed in their appointments (September 12):—S. M. T. Grimes, T. R. F. Handcock.

Accountant Branch

Flying Officer on probation R. G. Plumb is confirmed in his appointment (August 25).

The following Acting Pilot Officers on probation are graded as Pilot Officers on probation (July 31):—A. E. Anderson, A. F. Bacon, D. A. Birkett, R. H. Bradley, R. P. Breen, D. L. R. Brown, J. Buckley, J. E. Campbell, R. V. Carroll, J. Farley, M. M. Gardham, E. M. Greenwood, P. R. Grey, C. E. Harrison, D. C. King, V. O. M'Quillin, J. Mark, W. K. G. Nicholls, L. R. Pentelow, F. D. Pryce, E. P. Riddell, L. Royle, R. H. Simpson, W. S. Smith, C. H. Sparks, L. D. Vickery, R. A. Webster, G. E. White, J. F. Wilson.

Medical Branch

The following are granted short-service commissions as Flying Officers for three years on the active list with effect from September 4 and with seniority of the dates stated:—A. R. Agate, M.R.C.S., L.R.C.P.; J. L. Brown, M.D., Ch.B., M.R.C.S., L.R.C.P.; L. W. Davies, M.B., B.S., M.R.C.S., L.R.C.P.; M. McLellan, M.B., Ch.B.; F. T. Moore, F.R.C.S., L.R.C.P.; R. Napier, M.B., Ch.B., F.R.F.P.S.; W. R. Parker, L.R.C.P. and S., L.R.F.P.S.; J. W. Reade, M.B., Ch.B.; A. Wardale, F.R.C.S., M.B., B.S., L.R.C.P. (September 4); R. Maycock, M.R.C.S., L.R.C.P. (March 13); B. C. Curwood, M.B., Ch.B.; C. Huddlestone, M.R.C.S., L.R.C.P.; J. A. MacCarthy, M.B., B.Ch.; A. McDougall, M.B., Ch.B. (September 4).

Dental Branch

F. D. Baron, L.D.S., is granted a non-permanent commission as Flying Officer for three years on the active list (September 4).

Chaplains Branch

The notification in the *Gazette* of September 12 concerning Rev. O. R. I. Jones is cancelled.

Commissioned Engineer Officers

The following Warrant Officers are granted commissions as Flying Officers on probation with effect from the dates stated and with seniority of June 12:—P. J. Cains (August 10); W. A. Booth (August 14); W. L. Mills (August 22).

Flying Officer on probation T. Clare is confirmed in his appointment (July 20).

Commissioned Signal Officers

The following Warrant Officers are granted commissions as Flying Officers on probation with effect from the dates stated and with seniority of June 12:—C. T. Jackaman (August 10); E. F. Hawkins (September 5).

Royal Air Force Reserve

RESERVE OF AIR FORCE OFFICERS

General Duties Branch

The following are granted commissions in Class CC in the ranks and on the dates stated:—*Wing Commander.*—Col. E. St. G. Kirke, D.S.O. (R.A.R.O.) (August 17). *Squadron Leader.*—J. W. Martin (June 12). *Flight Lieutenants* (*Honorary Squadron Leaders*).—Lt.-Col. E. M. A. Hogan (I.A., Ret.) (April 3); Maj. C. B. Swift (R.A.R.O.) (August 28); Sec. Lt. H. K. Anstey, Flt. Lt. D. F. Cox, Maj. H. B. Davey, M.C., Lt. I. M. Davies, F/O. O. D. Freeman, Maj. H. St. C. Smallwood, Sec. Lt. M. Tait, Capt. G. T. Willcox, M.C. (August 30). *Flight Lieutenants.*—E. W. Carmichael, Lt. J. N. Mearns (July 10); Capt. M. E. S. Thompson, M.C. (July 12); Lt. A. E. Masters (July 21); Lt. A. H. Welsh (July 24); F. C. Hornsby-Smith (July 26); Capt. F. E. Sheppard (I.A., Ret.) (July 28); R. D. Boyd, Lt. G. S. M. Warlow (July 31); Lt. O. D. Norwood (R.A.R.O.) (August 1); Flt. Lt. F. R. Balfour (R.A.F.O.) (August 5); Capt. T. C. Chamberlin, A.F.C., Lt. J. C. H. W. Middleton-Stewart (I.A., Ret.) (August 8); Maj. H. G. Morrell (I.A., Ret.) (August 12); Capt. C. E. Lugard (R.A.R.O.) (August 14); Capt. H. Thrower (August 22). *Flying Officers* (*Acting Flight Lieutenants*).—F/O. J. T. Hall (R.A.F.O.) (July 24); F/O. D. J. Hughes-Morgan (R.A.F.O.) (August 15). *Flying Officer* (*Honorary Flight Lieutenant*). Flt. Lt. P. D. Baker (August 28). *Flying Officer.*—F/O. E. J. Dilnutt (R.A.F.O.) (April 18).

Lt. Col. W. R. Warden (I.A., Ret.) is granted a commission in Class CC as Flight Lieutenant with effect from July 21, 1938, and is granted the rank of Squadron Leader with effect from April 17; F/O. K. C. B. Woodman is granted the rank of Flight Lieutenant (August 1); Flt. Lt. F. R. Jones (R.A.F.O.) is granted the acting rank of Squadron Leader in Class CC (July 25); F/O. R. C. Warner (R.A.F.O.) is granted the acting rank of Flight Lieutenant in Class CC (July 24); Wing Cdr. J. R. Stewart, T.D., relinquishes the rank of Wing Commander with effect from August 1, and is reappointed in the rank of Flight Lieutenant, with effect from the same date and with seniority of October 12, 1938; F/O. R. S. Sikes is transferred from Class C to Class AA (August 14); Flt. Lt. (Honorary Sqn. Ldr.) T. F. G. Strubell relinquishes his commission on cessation of duty (October 1); Flt. Lt. M. G. Bircham relinquishes his commission on completion of service (June 2).

Equipment Branch

Flt. Lt. G. H. Ruse relinquishes his commission on cessation of duty (August 13).

Royal Air Force Volunteer Reserve

General Duties Branch

The following are granted commissions as Pilot Officers (September 2):—H. A. Dalrymple-White, K. O. Burt, D. W. Horrocks.

The following are appointed honorary Flight Lieutenants on the dates stated:—Maj. A. C. Hooton (July 3); Lt. Col. T. B. Skinner (I.A., Ret.) (August 17); Lt. Col. W. S. J. Scruby, O.B.E. (I.A., Ret.) (August 21); Col. R. B. Butler, C.I.E., C.B.E., M.C. (I.A., Ret.) (August 22); Lt. Col. H. A. B. Salmond (August 25); Vice-Admiral G. N. Tomlin, C.M.G., M.V.O. (August 28).

The following Flight Lieutenants are granted the honorary rank of Wing Commander on the dates stated:—J. L. C. White, M.C. (August 11); D. E. Robertson, C.B., D.S.O. (August 14).

F/O. W. L. Stranger is transferred to the Administrative and Special Duties Branch with his present rank and seniority (August 8).

Administrative and Special Duties Branch

W. A. K. Igoe is granted a commission for the duration of hostilities as Flying Officer (September 14); E. H. Keeling, M.P., is granted a commission as Pilot Officer on probation (August 29).

The following are granted commissions for the duration of hostilities as Pilot Officers on probation on the dates stated:—R. A. E. Birch (September 8); P. C. Cabot, C. S. Emden, D.F.C., H. J. Spencer (September 12); T. A. Newman, C. G. Slade (September 13); H. T. R. Cripps, W. H. McNeilly, G. P. Powles (September 14); P. L. Barrow (September 16); W. M. Ackery, D.F.C., R. G. C. Adams, W. L. Alderson, J. Armes, H. L. Assig, S. C. Bacon, R. Barrett, A. A. Bartram, B. I. Beal, A. C. Bencher, E. I. M. Bird, J. F. Birkbeck, C. H. Bizzell, P. R. Bordewich, J. S. Bosworth, N. W. B. Bovey, F. S. Bowles, M. L. Bramson, J. B. Briggs, L. H. Brown, H. C. T. Browne, H. E. Browne, P. F. Bruce, S. Buckenham, G. W. Burgess, A. E. Caen, W. K. Caldwell, A. A. Caney, F. V. Carpenter, E. J. Carthew, A. C. Case, F. N. Chadwick, F. G. Chapman, J. K. Chatham, A. E. Chester, J. A. Chubb, A. S. Clark, H. R. Clay, H. A. P. Coleman, R. R. F. Cookson, G. G. Cooper, W. F. Cotton, R. L. Cutler, C. S. Devereux, R. V. Dickins, J. N. Dixon, J. F. Downing, C. H. Dunster, I. A. E. Edwards, C.M.G., J. C. Emerson, H. S. Evamy, R. S. Falk, R. S. Felgate, E. S. Flatman, M. K. Forsyth, A. E. Francis, D. G. Francis, A. Gammion, W. T. Ganter, J. A. de Gaye, W. J. Gibbs, P. G. Goodger, R. W. Gosse, S. E. Grand, A. S. Graves, D. D. Gray, J. M. Griffiths, L. W. Grumbley, E. Hall, A.F.C., C. J. Hallward, E. F. Hawkins, D.S.O., R. E. Heath, R. W. Hemsley, H. A. Hewitt, A. C. Heyes, V. R. Hicks, J. W. Hicks, H. E. Hinchliffe, C. C. Hirst, C. W. R. Hodges, J. Hogan, H. S. Holloway, C. E. Holman, W. H. Holton, S. L. Hooper, S. T. Hosken, F. H. Hudson, H. G. Hudson, T. F. Hudson, T. J. Hudson, H. I. Hughes, R. N. H. Hughman, R. J. Hulburd, C. R. Humphries, R. H. Humphries, W. E. Humphreys M.B.E., W. E. Hunt, E. L. Ives, V. E. Jackson, F. F. James, F. B. Jeffries, V. C. B. Johnson, C. E. Jones, W. H. Jordan, K. E. Judd, R. W. Kerr, R. H. Kimber, D. H. King, A. E. King, R. E. C. Knight-Bruce, L. V. Labrow, J. B. Lacey, L. C. Lane, N. E. Lane, F. K. Langton, E. T. Lavarack, H. C. Lavers, N. K. Lawton, G. E. Leaman, J. T. Lean, W. H. G. Leggett, C. H. Leng, G. H. Leonard, B. E. Lewis, C. A. Lewis, F. D. Lloyd, N. S. Lott, A. E. Loveday, L. O. Ludgate, A. A. McConnell, B. C. McEwen, M.C., C. W. T. Macgillivray, T. C. McIlroy, M. S. Mackay, C. A. Mackenzie, C. B. McWeeney, J. W. Maddock, J. H. Mainwaring, O. W. A. Manning, E. Marler, E. G. Mattingley, T. J. Moloney, H. A. Moncrieff, A. K. Montagu-Beart, A. G. Mower, E. J. Munson, B. le B. Musgrave, C. S. Noble, A. North, A. R. Ogston, H. J. Oughton, W. P. J. Ovington, R. J. W. Palmer, P. K. Paul, L. H. Peter, W. G. Peters, H. H. Phillips, K. W. M. Pickthorn, M.P., G. E. Pickton, S. F. Pickup, H. E. S. Pilcher, C. B. Pinnock, E. R. Playford, F. J. Powell, M.C., G. R. Powell, C. E. Prescott, C. H. B. Price, H. J. Pritchett, J. H. Ratcliff, A. G. Raven, H. Ravenhill, R. T. Raw, A. B. R. Barker, J. C. Richmond, C. G. Rickards, J. G. Ridout-Evans, H. A. B. Robb, M.C., A.F.C., H. P. Roberts, G. Roller, T. W. Rowlands, H. Sacre, N. C. Sampson, H. Shackell, D. F. McD. Sinclair, C. F. Smith, W. M. Smith, C. W. Snook, E. P. Southby, H. G. Sullivan, R. G. Taylor, J. Tennant, M.C., W. H. Terry, W. H. Thomas, E. B. Thomson, R. H. Tooley, E. I. Treasure, P. H. Tremlett, K. S. Tugwell, W. R. Vaughan, C. Volk, W. H. P. Weston, F. F. Walter, H. R. Whittingham, H. Williamson, S. J. Wines, L. W. B. Winship, D. J. Wiseman, J. S. Wood, W. Woodstack, A. V. Woollett, L. G. Wright (September 19).

The following Pilot Officers on probation are confirmed in their appointments and promoted to the rank of Flying Officer on the dates stated:—P. H. Guimaraens (May 14); T. A. Tolhurst (June 17); C. L. Stubbs (August 15); A. E. C. Andrews (August 20); S. J. Griffin (August 30); J. C. S. Ahern, H. Arnold, J. A. Baghino, J. W. Blake, E. J. Bowen, F. H. Bowyer, A. V. Burbury, M.C., J. G. Burchett, M.C., W. H. Carr-Birbeck, H. D. Clevely, L. Cohen, D.S.O., M.C., G. L. Coleman, R. H. Collier, D.S.O., O.B.E., W. C. P. Dale, K. T. Dowding, D.F.C., J. D. E. Dudley, F. C. Edwards, J. F. Ellor, H. G. D. Ereckson, L. V. Foster, W. C. J. Foster, T. R. Fox, N. R. Fox-Andrews, C. H. Gardner, C. R. R. Gidney, R. E. Greensmith, R. Harcourt, A. Haynes, E. H. Henton, M.M., H. D. Higham, G. E. W. Hitchcock, W. Hurst-Barnes, H. V. Jellicoe, G. E. Johnson, S. G. Kingsley, M.C., S. N. Linsell, A. C. Lyell, M.C., D. Mumford, K. D. P. Murray, M.C., H. C. Page, F. J. Pope, C. F. Pugh-Davies, B. N. Radford, N. H. Richardson, W. H. C. Rollo, M.C., V. A. B. Scupham, E. M Selby, O.B.E., W. M. F. Sherwood, J. R. M. Simpson, G. A. L. Sinclair-Hill, O.B.E., A. E. L. Skinner, M.C., H. E. Symons, W. R. Tate, F H. P. Warmington, G. H. Williams (August 31); B. J. E. Belcher, D.F.C., H. M. Bentley, R. M. Colebrook, W. N. Craig, C. M. Davis, E. Evans, J. W. Greenshields, J. L. Hillary, W. H. R. Lukey, C. B. Matthews, L. W. B. Parsons, L. C. Pharoah-Band, C. G. Phillips, D. H. Scott, A. C. Smith, A. J. Spiers, H. J. Tanburn, W. E. Taylor, D. O. Thomas, R. C. Vaughan, A. J. Woodhouse (September 1); J. A. A. Barber, R. C. Collinswood, A. J. E. Forsyth, C. McEvoy, D.F.C., L. Norris, T. H. W. Pearce, D. Tidmarsh, M.C. (September 2); G. W. Adams, C. H. Badderly C. L. Berrington, F. A. Boyce, J. H. Brown, R. K. Budge, H. Edge, C. S. Goode, J. K. Hankinson, K. G. P. Hendrie, J. H. C. Hunter, K. Jowers, C. L. A. Le Baron Whyte, G. L. S. Lightfoot, E. A. Marriott, S. G. Morgan, C. I. Orr-Ewing, C. A. J. Plant, C. A. G. Quarrington, H. W. Scarnell, M.M., G. R. Scott-Farnie (September 3); J. Brooker, P. H. Dorte, M. C. Evans, F. E. Everard, C. A. Lewis, M.C., G. Lynch, R. Messulam, W. G. M. Money,

C. R. Plant, F. H. Rae, A. F. Trinder, G. L. P. Zech (September 4); H. B. Dent (September 5); H. C. Bevan (September 6); B. S. L. Champion, J. C. Hosburn, N. S. Sennett (September 7); F. C. Faulkner, R. M. Fletcher, L. F. Hodges, R. T. Wilson (September 8); M. A. Harker (September 9); H. J. Lewis (September 11); C. Blake-Smith (September 12).

Equipment Branch

The following are granted commissions for the duration of hostilities as Acting Pilot Officers on probation (September 9):—B. H. Allin, J. Beaton, J. L. Bush, D. A. Collins, L. F. Collins, P. A. L. Cooper, W. J. F. Fenton, S. G. Jenkins, R. H. Knight, A. L. Scull, J. M. Warner, R. H. Warr, A. P. Woodyatt, J. H. G. Wilson.

Accountant Branch

C. W. Myring is granted a commission for the duration of hostilities as Pilot Officer (September 18).

The following are granted commissions for the duration of hostilities as Acting Pilot Officers on probation on the dates stated:—D. R. Anderson, H. V. Barham, H. J. Binder, G. Broadhurst, W. H. B. Carey, H. A. Cuming, E. G. H. Downes, A. E. Dunnill, H. R. Elliston, W. S. McCallum, N. Mayhew, A. R. Pedley, F. J. Readings, F. N. Shillito, N. G. Simpson, J. R. Skelton, G. S. Stone, J. O. Wheeler (September 11); N. C. Billington, S. K. Peer, A. H. Wilkes (September 12); W. G. Evans (September 14).

Medical Branch

J. J. Conybeare, M.C., M.D., F.R.C.P., is granted a commission for the duration of hostilities as Group Captain (September 11).

Meteorological Branch

The following are granted commissions for the duration of hostilities in the ranks stated (September 19):—*Flight Lieutenant.*—G. W. Hutst. *Flying Officer.*—A. E. Mayers. *Pilot Officers.*—B. A. Copping, D. K. Fraser, E. E. Jessop.

Auxiliary Air Force

General Duties Branch

Flt. Lt. J. W. Martin relinquishes his commission on appointment to a commission in the Reserve of Air Force Officers (June 12). No. 500 (County of Kent) Squadron.—A. R. Cousins is granted a commission as Acting Pilot Officer on probation (August 31); P/O. W. H. Corry relinquishes his commission on account of medical unfitness (July 17). No. 501 (County of Gloucester) Squadron.—F/O. E. S. Williams is granted the acting rank of Flight Lieutenant (unpaid) (August 21). No. 502 (Ulster) Squadron.—P/O. J. S. N. Sewell is promoted to the rank of Flying Officer (September 1). No. 604 (County of Middlesex) Squadron.—P/O. A. S. Hunter is promoted to the rank of Flying Officer (October 17, 1938). No. 608 (North Riding) Squadron.—F/O. P. K. Stead is granted the acting rank of Flight Lieutenant (unpaid) (August 14). No. 610 (County of Chester) Squadron.—F/O. A. T. Smith is granted the acting rank of Flight Lieutenant (unpaid) (August 11). No. 611 (West Lancashire) Squadron.—Acting P/O. B. Heath is promoted to the rank of Flying Officer (August 29); F/O. K. M. Stoddart is granted the acting rank of Flight Lieutenant (unpaid) (August 10). No. 612 (County of Aberdeen) Squadron.—F/O. A. M. Scott is granted the acting rank of Flight Lieutenant (unpaid) (August 14). No. 613 (City of Manchester) Squadron.—N. A. Copley-Smith is granted a commission as Flight Lieutenant (September 2). No. 615 (County of Surrey) Squadron.—P/O. W. O. Stern is promoted to the rank of Flying Officer (July 23). The following Flying Officers are granted the acting rank of Flight Lieutenant (unpaid) (August 15):—P. N. Murton-Neale, L. T. W. Thornley. No. 904 (County of Surrey) Squadron.—The following Flying Officers are promoted to the rank of Flight Lieutenant (August 29):—A. Leon, A. J. Beard, M.C., E. St. H. Davies, C. T. Fitzgerald. No. 905 (County of Surrey) Squadron.—B. M. Russ-Turner is granted a commission as Pilot Officer (August 14)). No. 907 (County of Middlesex) Squadron.—R. W. Chamberlain is granted a commission as Pilot Officer (September 1). No. 908 (County of Essex) Squadron.—L. R. Last is granted a commission as Pilot Officer (August 31). No. 910 (County of Essex) Squadron.—The following are granted commissions as Acting Pilot Officers on probation on the dates stated:—G. B. Cuthbertson (August 24); J. E. Lloyd (August 25). No. 911 (County of Warwick) Squadron.—E. H. King is granted a commission as Acting Pilot Officer on probation (August 29).—No. 912 (County of Warwick) Squadron.—G. J. Barnes is granted a commission as Acting Pilot Officer on probation (August 31). No. 914 (County of Warwick) Squadron.—The following are granted commissions in the ranks and on the dates stated:—*Pilot Officer.*—K. G. Kent (July 30). *Acting Pilot Officer on probation.*—T. P. Wheelock (August 28). No. 915 (County of Warwick) Squadron.—E. H. Colley is granted a commission as Acting Pilot Officer on probation (August 30). No. 917 (County of Warwick) Squadron.—W. J. Bond is granted a commission as Acting Pilot Officer on probation (August 30). No. 919 (West Lancashire) Squadron.—R. H. Hayward is granted a commission as Pilot Officer (August 28). No. 922 (West Lancashire) Squadron.—The following are granted commissions as Acting Pilot Officers on probation (August 20):—J. M. S. Hogg, J. H. Hayes. No. 923 (County of Warwick) Squadron.—The following are granted commissions as Acting Pilot Officers on probation (August 24):—S. S. Wheeler, A. W. Bacon. No. 925 (East Lancashire) Squadron.—R. N. C. Racker is granted a commission as Acting Pilot Officer on probation (August 29). No. 930 (Hampshire) Squadron.—G. B. Monkman is granted a commission as Flying Officer (August 29). No. 931 (Hampshire) Squadron.—J. O. Fane is granted a commission as Acting Pilot Officer on probation (August 29). No. 933 (Hampshire) Squadron.—C. W. Kiln is granted a commission as Acting Pilot Officer on probation (August 30). No. 935 (County of Glamorgan) Squadron.—The Right Hon. the Earl of Plymouth, P.C., is appointed Honorary Air Commodore (September 11). No. 942 (East Riding) Squadron.—D. E. Yonge is granted a commission as Pilot Officer (August 21). No. 943 (East Riding) Squadron.—The following are granted commissions as Pilot Officers on the dates stated:—L. H. Kirkby (August 21); H. C. Radcliffe (August 25). No. 944 (East Riding) Squadron.—The following are granted commissions as Pilot Officers on the dates stated:—J. R. Lloyd, S. H. Holland (August 21); J. H. Holland (August 25).

Administrative and Special Duties Branch

No. 500 (County of Kent) Squadron.—The following are granted commissions in the ranks and on the dates stated:—*Flying Officer.*—E. A. Spencer-Edwards (July 22). *Acting Pilot Officer on probation.*—L. S. Litchfield (September 1). No. 612 (County of Aberdeen) Squadron.—R. M. Johnson is granted a commission as Pilot Officer (September 2).

Equipment Branch

Flt. Lt. R. Burges relinquishes his commission on cessation of duty (September 11). No. 924 (East Lancashire) Squadron.—H. Burgess is granted a commission as Pilot Officer (August 25). No. 931 (Hampshire) Squadron.—H. R. Dibben is granted a commission as Pilot Officer (August 30).

Auxiliary Air Force Reserve of Officers

General Duties Branch

No. 601 (County of London) Squadron.—The Hon. W. D. S. Montagu is granted a commission in Class A as Flying Officer (September 1).

GROUND ATTACK: One of the most successful of the new types being introduced to the French Air Force is the Bréguet 690 multi-purpose monoplane with two Gnome-Rhône 14 M engines. Three of these attractive machines are shown performing at the International Meeting at Brussels this summer.

FUELS and ENGINES

Plugs : Direct Injection : The Diesel : High-power Engines of the Future

By F. R. BANKS

(*Continued from page 270*)

Sparking Plugs

ON the subject of sparking plugs, Mr. Banks said that he considered that the mica type plug was approaching its limit of usefulness and reliability for high-duty engines, and he thought its place would be taken during the next few years by the sintered aluminium oxide plug. He explained that plugs of this material were first produced by Siemens of Germany under the trade name "Sinterkorund." The principal advantage of sintered aluminium oxide was that it was not attacked by the combustion products of leaded fuels. One of the main difficulties had been to ensure gastightness of the finished plug, and also of avoiding cracking of the insulator nose due to the differential expansion between the insulating material and the central electrode. These difficulties had been satisfactorily overcome, and the sintered aluminium oxide plug was now past the experimental stage. Already it was used successfully in large quantities in Germany for high-duty engines.

One plug development which had proved beneficial both to the mica plug and the sintered aluminium oxide type was the fine earth wire. These wires, made of platinum/iridium or platinum/rhodium alloy, were arranged in numbers from four to eight radially around the central electrode. The use of these earth wires had increased the period between removal and overhaul, but had decreased the total life of the plug somewhat.

Concluding this section of his paper, Mr. Banks said that there was previously an impression in England that American sparking plugs were superior to the British, but as a result of tests, in the form of fitting American plugs in British engines and British plugs in American engines, the conclusion had now been arrived at that British plugs compared favourably with the American types.

Direct Injection

Although he had dealt with the subject of direct injection in an early part of his paper, Mr. Banks returned to it again later on. He said that, apart from the work carried out by the U.S. Army Air Corps some years ago, nothing further seemed to have been done until, a year or so ago, the German aero engine firms got busy. They now had injection systems in quantity production for all their high-duty engines. Little information was available on German development beyond the fact that all the injection systems used appear to spray direct into the engine cylinders, both on air- and liquid-cooled types.

"There are statements (unofficial)," Mr. Banks continued, "to the effect that direct injection has improved the fuel consumption of some German engines by 10 to 15 per cent. This condition may be so in the case of the liquid-cooled types, which previously had pressure carburetters (the carburetter between the blower and the engine), since, with the carburettor in this position, it appears to be more difficult to obtain good fuel consumption than when it is fitted on the suction side of the blower. Although there is, as yet, little evidence or experience of the pressure carburetter to confirm that this condition is necessarily so in every case, I think, however, that the pressure type must present greater difficulty in obtaining satisfactory fuel distribution because it is placed closer to the cylinders, with a shorter length of induction piping intervening. Thus, there is less time or opportunity for obtaining a homogeneous mixture before the charge reaches the cylinders. And the carburation is also likely to be affected by pulsations from the individual cylinders. Lastly, because the fuel is not taken through the blower, the efficiency of the latter will be (adversely) affected. In the case of air-cooled engines, with suction carburetters, the improvement in fuel consumption due to the injection system will probably be in the order of 2 or 3, perhaps 5 per cent. at cruising condition.

"I consider that timed injection to the individual cylinders, either spraying direct into the combustion chamber or, in the case of very small cylinders (where it is difficult to find room for the injector in the head), into the inlet port immediately behind the valve, is worth a serious trial, particularly in the case of large multi-cylinder supercharged engines in which distribution difficulties are likely to be encountered. The principal difficulties which will be encountered with the timed injection system will concern the control of the fuel and air in order to obtain the correct mixture strengths required for take-off, cruising, and changing altitude conditions. Also, a considerable amount of experimentation will be necessary in order to determine the correct placing of the injector in the cylinder head. The fuel should not spray on to the cylinder walls; otherwise excessive oil dilution and piston scuffing may occur. It has been found, in some cases, beneficial to inject from about the centre of the cylinder head towards the piston crown, with a somewhat narrow spray angle. The warm crown helps to vaporise the fuel, and the latter assists in giving some measure of direct cooling to the piston.

Reduced Fire Risk

"The potential danger of a distribution system full of inflammable mixture at relatively high pressure is eliminated. The question of intercooling also is simplified, since air only can be dealt with more easily and safely. It is true, of course, that taking the petrol through the supercharger is responsible for a drop in charge temperature of, roughly, 25-30° C., and the blower efficiency is improved for this reason. But, in the case of highly boosted engines, particularly those types which for military purposes will operate at low altitudes, it will probably be necessary to cool the air from the supercharger to the engine in any case. The supercharger, when dealing with air only, must be larger in consequence.

"One important feature of direct petrol injection is that the consumption 'loop' (specific fuel consumption versus b.m.e.p.), both in the case of single-cylinder units and full-scale engines, generally can be carried well round the bend in the weak-mixture range—further than is usually possible with the carburetter system.

"The use of high-octane blending agents and fuels having relatively low volatility might be possible with direct injection. It certainly would be advantageous in the case of fuels subjected to prolonged storage and also for high-altitude flying, tending to reduce loss and avoid vapour lock in the fuel system.

"Starting is made easier because one has, literally, a priming device to each cylinder, and warming up is necessary only on account of the lubricating oil and, perhaps, the cooling system; the latter, in order to avoid too rapid thermal changes. The response of the engine to the throttle is immediate in all those engines I have seen which have direct injection.

"The risk of damaging the engine when operating on weak mixtures is reduced with the injection system due to better distribution, and the fuel consumption should, for the same reason, be improved by, say, 5 per cent., at cruising powers. A further advantage from the military viewpoint concerns the engine behaviour when 'idling,' in the case of 'silent approach' tactics—where bombers will reach a high altitude during their flight and then, when approaching their objective, will glide for some

distance without engine until they are over their target. There will be no overloading of the distribution system with 'wet' fuel, nor should the engines fail to pick up immediately upon opening the throttle again."

The Diesel Engine

On the subject of the compression-ignition engine Mr. Banks said that, with the exception of the Junkers firm in Germany, but little progress had been made, and even the Junkers engine could not be said to be more than a very successful experiment at present. A number of machines were flying with this type of engine in Germany, but the Junkers engine suffered from the common trouble associated with the C.I. principle, namely, relatively low take-off power, and no really high-performance machines, military or civil, were fitted with it.

He pointed out that one of the obstacles to great improvement in the C.I. engine was that, in spite of the work done during the last ten or fifteen years, this type of engine was still a somewhat wasteful consumer of air. The successful development of the compression-ignition aero engine therefore depended mainly on large supply of air for a low expenditure of power. This would involve investigation of blower efficiency and would be particularly necessary in the development of the two-stroke engine in which the blower must be of sufficient capacity to scavenge the engine and restore sea-level power at altitude.

The elimination of electric ignition and radio shielding were advantages of the diesel engine. Reduction of fire risk was another, and although some thought that fire would still occur, he doubted whether there was the same risk as with petrol in case of a crash. Even if fire did occur there would not be the sudden and inferno-like blaze which was characteristic of the petrol fire.

The difference in specific consumption between the modern petrol engine and the diesel engine was not great, and he thought that an aeroplane fitted with diesel engines would have to fly for six hours or more before the lower consumption of the diesel could be worth while from the payload point of view. Therefore, except on long air routes or for ocean crossings, there did not seem to be much advantage in using the compression-ignition engine.

Future Engine Development

Mr. Banks indulged in some interesting speculations concerning the aero engine of the future. He explained that since most large engines would be developed to meet military needs, his paper would discuss mainly the development of engines for military purposes.

"It would appear," he said, "that engines of 2,000 b.h.p. up to 5,000 b.h.p. will be required and developed during the next few years. What form will they take? In the first place, I think the liquid-cooled engine will be used more generally than it has been in recent years for powers in excess of 2,000 and 2,500 b.h.p. This prediction applies equally to military and civil aviation. And the air-cooled engine probably will have to give up its place in general popularity to the liquid-cooled type.

"This statement does not mean that any particular limit is foreseen in regard to air-cooling, as such. But, since multi-cylinder in-line engines probably will be employed for these powers, and still higher specific power outputs will be 'the order of the day,' liquid cooling appears to offer more scope in dealing with the increased heat flow which will be encountered, and in maintaining a compact design to blend in better with that of the aircraft structure. Compactness and rigidity are easier to obtain with the liquid-cooled engine because the cylinders are pitched closer to each other and block cylinder construction can be employed.

"The problem of developing the large engine will be to decide upon the size of the individual cylinder and the number and arrangement of the cylinders. There probably will be three main engine types, mostly liquid-cooled: the X engine with four banks of six cylinders each arranged at 90 deg. or paired at 60 deg. to each other; the H engine, arranged vertically or on its side as a flat engine, with four banks of six cylinders each and two crankshafts; and the multibank radial engine with in-line cylinder arrangement.

"For smaller engines than the foregoing, but where extremely high performance and compactness are required for fast fighters, the present 60-deg. V-type 12-cyl. engine, upright or inverted, probably will be retained, or a flat engine with two banks of 6 or 8 cyl. each, opposed, will be produced.

"In the case of the V-type engine, I am not sure that there is any particular advantage to be gained by inverting it (which is the practice in Germany), at least not for single-engine aircraft, since, by doing so, unless one resorts to an epicyclic-type reduction gear, the propeller will have less ground clearance, or the undercarriage must have longer legs. The pilot's view will be little better, if as good; and, although the exhaust stacks will be out of his way, they will, in their new position, most probably be in line with the leading edge, which is also unsatisfactory. Neither would the inverted engine seem particularly advantageous for the twin or multi-engine low-wing monoplane or where a tricycle landing gear is used, on the score of propeller clearance. The normal V and the flat engine appear to score in most of these respects.

That "Buried" Engine

"Designing and building an engine to be installed completely within the wing still appears to be as remote a possibility as it was some years ago when many prophesied that future engines would be buried in the wings of the larger multi-engine machines. Unfortunately, wing thickness is not increasing to the extent at first expected, since the higher speeds of recent years, and still higher to come, apparently demand as thin a wing as possible and, of course, larger engine powers, making the installation of an engine within the wing a difficult problem to tackle.

"In these very large engines, the use of steel for the crankcase, stamped in sections and either welded or bolted up, might be preferred to aluminium alloy. The weight of the finished case should not necessarily be greater than one of aluminium. In addition, due to the lighter scantlings of the steel case in comparison with one of aluminium, there will be more chance of controlling the lubricating oil and it will not be spread about so badly by the moving parts, which is often so with an aluminium case, as the use of the latter reduces the free space.

"In regard to the H engine, I do not think that this cylinder and crankshaft arrangement has any attraction for engines of less than, say, 1,500 or 2,000 b.h.p. But it has its points for really large engines. It would seem impracticable at present to use a built-up crankshaft for the multibank in-line engine on account of space and weight considerations. Therefore, a master rod with a split big-end must be considered. In this connection, the H engine, with two crankshafts and only two rods per crankpin, offers some advantages in comparison with a master-rod having three, or more, link rods, as in the case of the X- and radial in-line arrangements.

Cylinder Size and Form

"So much for the number and arrangement of cylinders; now for the optimum cylinder size and form. If one considers the successful operation of air-cooled cylinders of about 6in. in diameter, and even a fraction larger, and also, the 6in. liquid-cooled cylinder used for the Rolls-Royce 'Buzzard' engine of some years ago, which latter engine was developed into the successful 'R' or racing model, the conclusion is reached that the 6in. cylinder is a very useful size upon which to standardise (if one dare mention the word 'standardise' in connection with aviation engines) for large engines of the future. Actually, of course, the cylinder sizes used by the various firms have remained standard for a long period, even if the rest of the engine and the cylinder arrangement have been altered. There is everything to recommend the adoption of a standard cylinder bore.

"If I were faced with the problem of designing and developing a really large engine, I would have some difficulty in deciding whether to use the single-sleeve or the poppet valve, for the reasons previously stated. Bearing those particular points in mind and also the fact that the sleeve-valve itself demands, at present, protracted and

costly development, it then depends upon the time (and, perhaps, money) factor as to whether a chance should be taken on the sleeve or not. If speedy development were absolutely necessary then, I think, one might retain the poppet valve for the in-line type engine, at present.

"Very careful attention to valve, cylinder, and piston cooling should allow a compression within half a ratio of that possible with a sleeve-valve, with a fuel of a given octane number, and, as mentioned previously, the limitation which usually prevents a higher compression ratio from being used in aviation engines is the steep rise in peak combustion pressures resulting from such increase. It is doubtful whether the rotary and conical type valves, such as the Cross and the Aspin, will be used for the high-duty aviation engine, but the latter might be applied to the lower-duty types.

General Design

"Having decided upon the cylinder bore to be used, the general design of the engine and its dimensions can now be settled. In order to make a compact design, a bore/stroke ratio of 1 : 1 or one of 1 : 1.1 (the latter dimensions are those of the Rolls-Royce 'R' engine) is recommended, giving a cylinder of 6 × 6in., or 6 × 6.6in. bore and stroke. The flat cylinder head is the most suitable type for compactness, and the bore/stroke ratios mentioned, particularly the former, are very satisfactory for this type of head, in order to provide adequate valving. Either three or four valves may be used. Although I prefer the three-valve arrangement (two inlets and one exhaust) for cylinders of about 5 to 5½in. bore because the exhaust valve has a better chance of being cooled properly and the valve-operating mechanism is somewhat simplified, the larger cylinder (6in.) naturally demands a bigger valve, which may cause operational difficulties at speeds around 3,000 r.p.m. Therefore, it may be desirable to use four valves in this case, although the former arrangement is worth trying in the early development stage, and, in any case, the exhaust port area always may be somewhat smaller than the total inlet-port area, permitting a smaller exhaust valve.

"In order to obtain good airflow (breathing) for the cylinder, do not, with the multi-valve arrangement, use siamesed or common inlet ports, and this statement applies also to the exhaust valves where two are to be used. Make each valve port separate, to connect to the induction or the exhaust pipe. In the case of inlet valves, siamesed ports generally make for poorer charging efficiency and, with a common exhaust port, the exhaust valves can feed back heat to each other. The jacketed portion of the exhaust porting should be kept as short or brief as possible in order to avoid putting any more heat than is necessary into the cooling system. The exhaust stacks should be directly cooled by the airstream and face rearwards, so that they discharge with, and not at an angle to, the airstream.

Wet or Dry?

"A big question with the liquid-cooled engine is whether to use a wet or dry cylinder barrel. This choice will depend upon the type of cylinder-block construction employed. If a modern version of the older type cylinder with a welded-on head and valve-port arrangement and welded-sheet jacket is contemplated, then the answer is obvious. But if the aluminium block and steel liner is used, a decision is more difficult to make. All in all, I think I might choose the dry liner in order to reduce to a minimum the risk of plumbing troubles. In practice, this type of construction does not seem to suffer from the defects which might be expected in view of the relative remoteness of the coolant and the degree of thermal contact obtained between the liner and the aluminium outer barrel surrounding, or enclosing it.

"The size and type of engine will be governed by the class of aircraft for which it is to be used. Long-range heavy bombers in a few years will be fitted with two engines of the X or the H type having 24 cylinders each, giving powers up to, say, 5,000 b.h.p. per engine, at about 18,000ft. This arrangement will mean an engine of about 73.2 l. (4,465 cu. in.) cylinder capacity, 6 × 6.6in. bore and stroke, running at 3,000 r.p.m. with a (maximum) b.m.e.p. of about 295 lb. per sq. in. This class of engine must have a high take-off power and cruise at a very low fuel consumption, in the order of 0.38-0.40 lb. per b.h.p.-hr., which means that fuel of the "100-octane" variety probably will be used for both purposes. Direct petrol injection may replace the carburettor and a two-speed blower will be fitted for maintaining performance at low altitudes, particularly in the case of the low approach to the objective, to avoid anti-aircraft measures. I do not think that the four-engine bomber will be so popular as the optimum speed and range (for load-carrying) appear to be met more satisfactorily by the twin-engine machine.

"To escort such bombers into enemy territory and to draw the fire of single-seat fighters there, or to meet enemy bombers well before they reach their objective, it will be necessary to have fast long-range twin-engine multigun, or cannon fighters. For these, the 60-deg. V or inverted V, or the 'flat' engine having 12 cyl. of about 33 to 36.6 l. (2,013 to 2,232 cu. in.) total capacity will be required. These engines each will produce 1,500-1,600 b.h.p. or more at 18,000ft., at 3,000 r.p.m., and also will have high take-off power and low fuel consumption. Again, the two-speed blower will be necessary.

The Single-seater

"The single-seat, single-engine short-range fighter always will be used, and it is *pro rata* or, power for power, faster than the twin-engine fighter. Similar engine types to those suggested for the twin-engine job will be used, but these types will give a higher power output (on 100-octane fuel) at the same or at greater altitude than the latter engines with less dependence upon fuel consumption—about 2,500 b.h.p. or 1.20 b.h.p. per cu. in. Such engines, whether the 60-deg. V or the 'flat' type, will have a bore and stroke of 6 × 6in. and operate at 3,200 r.p.m., with a maximum b.m.e.p. of approximately 300 lb. per sq. in. The two-speed blower will be necessary for full-throttle performance at low altitude in order to deal with bombers employing 'low-approach' tactics.

"The two-speed blower is a necessity for present-day military engines and those of the immediate future, but it has its limitations and there also must be an appreciable compromise in regard to its efficiency, since it has to operate at either of two different gear ratios, or speeds. It has, however, one merit which, I believe, was unsuspected when this type of blower was first employed, and that concerns its operation at the altitude, or altitudes, normally embraced by it when in the high-speed gear position. For cruising purposes, and at any altitude at which the high-speed gear normally would be used, the low-speed gear can be engaged instead, and this operation enables a large throttle opening to be used, up to full throttle, above the critical 'low-speed' altitude, thus improving the overall operating efficiency and tending to reduce fuel consumption.

"The main object of the two-speed blower is to allow the aircraft to operate at the lower altitudes, near the ground, at a large percentage of throttle opening without detonation troubles. This operation is possible because of the lower pressures and temperatures obtaining when the blower gear is in low-speed position. I am of the opinion, however, that this blower is an intermediate step between the single-speed and multi-stage types. The development of a satisfactory variable- and controllable-speed mechanism for the blower drive would be very desirable.

"The exhaust turbo-blower probably will be employed widely for engines of the future. Apart from its obvious advantages at the greater altitudes, this type of blower does not absorb such a large proportion of the available engine power and accounts for less of the engine m.e.p. than do the mechanically driven types. This feature is particularly valuable and should reflect favourably on the specific fuel consumption. There is, in America, more practical experience with this type of blower than in any other country and, therefore, I do not feel qualified to say more regarding its possibilities, except to pose the following question: Will it be necessary, with a turbo-blower, to have also a mechanically driven one in order to deal with rapid

engine accelerations and to give immediate response, in boost, at take-off or for other engine conditions demanding a certain measure of flexibility?

"I have purposely discussed the very high-powered engine because I feel that it will be needed and developed well within the next ten years. And, since engines of 1,500 b.h.p. exist and others up to and exceeding 2,000 b.h.p. already are in an advanced state of development, it seems to me that now is the time to discuss the type and form of the future engine."

PERFORMANCE ESTIMATION

(*Continued from page 294d*)

The process is reliable up to high values of Δv, with the same degree of accuracy, as may be seen by checking the last line of the "Range" Table as above. Thus :—

$$B = -\frac{64,550^2}{19,000} = 219,300$$

v	ρv^2	19.0 ρv^2	$\frac{219,300}{\rho v^2}$	D_T	$\frac{1,804,000}{v}$	ΔT
368	202.6	3,850	1,080	4,930	4,903	− 27
Try						
367	201.5	3,829	1,089	4,918	4,916	− 2

The error is again seen to be 1 ft./sec., or less than 1 m.p.h.

Now suppose the parasite drag area in the above case to be decreased by 10 per cent., or :—

$$\frac{\delta A}{A} = -0.10 \quad \text{New } A = 17.1$$

From the table above :—

$$\frac{D_i}{D_p} = \frac{1,089}{3,829} = 0.2845$$

Then, by expression (6) :—

$$\frac{\delta v}{v} = -0.1\left(\frac{1}{0.2845 - 3}\right) = 0.0368$$

or :—

$$\text{new } v = 367(1 + 0.0368) = 381 \text{ (say)}$$

Checking this :—

v	ρv^2	17.1 ρv^2	$\frac{219,300}{\rho v^2}$	D_T	$\frac{1,804,000}{v}$	ΔT
381	217.0	3,710	1,011	4,721	4,740	+ 19
Try						
382	218.0	3,730	1,005	4,735	4,725	− 10

The error is seen to be about 0.5 ft./sec.

Now suppose the weight to be increased by 10 per cent., (the original parasite drag area being assumed) or :—

$$\frac{\delta W}{W} = 0.10 \quad \text{New } B = 265,000$$

From the same table as previously :—

$$\frac{D_p}{D_i} = \frac{3,829}{1,089} = 3.520$$

Then, by expression (7) :—

$$\frac{\delta v}{v} = \left(\frac{2}{1 - (3 \times 3.52)}\right) \times 0.1 = -0.0209$$

or :—

$$\text{new } v = 367(1 - 0.0209) = 359 \text{ (say)}$$

Checking this :—

v	ρv^2	19.0 ρv^2	$\frac{265,000}{\rho v^2}$	D_T	$\frac{1,804,000}{v}$	ΔT
359	192 8	3,663	1,374	5,037	5,025	− 12
Try						
358	191.7	3,642	1,382	5,025	5,040	+ 15

The error is seen to be about 0.5 ft./sec.

(Equations (6) and (7) should not be used for changes in A and W more than about 10 per cent.).

The change in parasite drag area necessary to balance this 10 per cent. increase in weight is found as follows :—

As before :—

$$\frac{D_i}{D_p} = 0.2845$$

From Fig. 3

$$K_a = -0.212$$

Hence : by equation (8) :—

$$\delta A = 19 \times -.212 \times .2845 = -1.15$$

or

$$\text{new } A = 17.85$$

Checking this :—

v	ρv^2	17.85 ρv^2	$\frac{265,000}{\rho v^2}$	D_T	$\frac{1,804,000}{v}$	ΔT
367	201.5	3,597	1,315	4,912	4,916	+ 4

i.e., practically an exact check.

Equation (8) is reliable over the whole range of $\frac{\delta W}{W}$ plotted on Fig. 3.

It is unnecessary to give examples of the use of equations (9)-(12) as these are simple and rigid, or of the method of estimation of Absolute Ceiling, as no simple check is possible here—the method has been found to give good results, however

REFERENCE

1. N.A.C.A. Technical Report No. 218: Standard Atmosphere—Tables and Data.

HARDNESS NUMBERS

THE British Standards Institution has just issued a table of approximate comparisons of Hardness Numbers B.S. No. 860.

With the increasing adoption of hardness testing there has arisen a need for a means of comparing the units of hardness of one system with those of another.

At present the most widely employed methods of measuring hardness are the "Brinell," "Diamond Pyramid," and "Rockwell" tests. There are individual preferences for using these, but cases are increasing where the same material is tested in different works or laboratories by those three different methods. There has, in consequence, been a general demand for some means of correlating the most used A, B and C Scales of the Rockwell test with those of the Brinell and Diamond Pyramid tests.

Investigations show that there can be no general theoretical relationships between these scales and empirical formulæ devised from experiments only hold closely for materials of approximately similar composition and in a given condition. "Variations" in the empirical relationships result if the conditions as regards composition, heat-treatment and cold work differ appreciably, and also if different loading ratios are selected in the Brinell test. On the other hand, groups of materials which are similar as regards composition, cold work, etc., may give fairly close comparisons.

It has accordingly been emphasised that the table is at the best a general approximation. It is issued merely to give an indication of the order of the relationship between the three systems of Hardness Readings, and must not be used as a standard for the conversion of hardness values given on one scale in any B.S. Specification to those of another scale.

The Diamond Pyramid Scale has been taken as the basis of reference and the most probable comparative values adopted from published experimental results.

Copies of the above British Standard can be obtained from the British Standards Institution, 28, Victoria Street, Westminster, London, S.W.1 (price 2s. 2d., post free).

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PERFORMANCE ESTIMATION

Some Useful Formulae and Methods, with Special Reference to Induced Drag

By C. F. TOMS

THESE notes present certain formulae and methods that have been found useful in routine performance estimation and in design. They refer to the estimation of the effect of induced drag on steady level flight speed, and the effect of changes in parasite drag and weight on steady level flight speed. In addition the expressions, in convenient "constant" form, for the minimum drag and power required are given, with the associated speeds.

Two applications of the formulae developed are shown.

No attempt is made to deal with the actual estimation of the parasite drag of an aeroplane—attention is confined to the use of the appropriate constant when it has been estimated.

The Drag of an Aeroplane

For the purpose of these notes, the drag of an aeroplane is expressed in the usual two parts—parasite and induced; the latter corresponds to the second term of equation (1), below, which is only valid for a completely air-borne aeroplane; this is in accordance with the conditions considered.

Thus we have:

$$D_T = A\rho v^2 + \frac{B}{\rho v^2} \quad .. \quad .. \quad .. \quad .. \quad (1)$$

where: A = parasite drag area $= C_{D_p} \cdot \frac{S_W}{2}$

B = induced drag constant $= \frac{2}{\pi}\left[\frac{W}{b}\right]^2 K_1$

and: S_W = wing area in sq. ft.

W = all-up weight in lb.

b = wing span in ft.

K_1 = a constant, usually between 1.0 and 1.3, to allow for the deviation of the wing load grading from the elliptic form, and for the tail-load.

We shall also use the symbols:

ρ = air density in slugs/cu. ft.

v = velocity in ft./sec.

C = thrust constant $= 550 \cdot \eta \cdot$ B.H.P.$_{(Total)}$

η = nett airscrew efficiency.

It should be noted here that the values of A, B and C used in any of the formulae must be those appropriate to the expected result to be obtained from the formula. It is necessary to make this stipulation, since A suffers an increase if the lift coefficient of the wings exceeds a certain value, and B varies slightly with tail-load, as already stated, and hence with speed, and η, hence C, is dependent upon speed. A satisfactory estimate can usually be made prior to using the formulae, or a process of approximations may be employed.

The Effect of Induced Drag on Level Flight Speed

The method developed here for estimating the decrement (Δv) of level flight speed due to the induced drag is thought to be original. Although it is approximate, it gives results accurate enough for practical purposes, and has the advantage that no charts are required for its use.

In steady level flight the airscrew thrust is equal to the total drag, or

$$\left.\begin{aligned} \frac{C}{v} &= A\rho v^2 + \frac{B}{\rho v^2} \\ \text{or} \quad C &= A\rho v^3 + \frac{B}{\rho v} \end{aligned}\right\} \quad .. \quad .. \quad (2)$$

For convenience we will write this thus:

$$C = P_p + P_i$$

Now if we neglect the presence of the induced drag it is a simple matter to calculate what we will call the "parasite" speed, v_p

Thus $$v_p = \left[\frac{C}{A\rho}\right]^{1/3} \quad .. \quad .. \quad .. \quad (3)$$

If Δv be the decrement of this speed due to the induced drag, the true level speed is:

$$v' = (v_p - \Delta v)$$

From (2) we have, at the true level speed:

$$P_i' = \frac{B}{\rho v'} = \frac{B}{\rho(v_p - \Delta v)}$$

and also $$\frac{d(P_p)}{dv_p} = 3A\rho v_p^2$$

At the true level speed (v') the actual induced drag will be equal to the difference between the parasite drags at speeds v_p and v', or:

$$\frac{B}{\rho(v_p - \Delta v)} = 3a\rho v_p^2(\Delta v)$$

for small values of Δv.

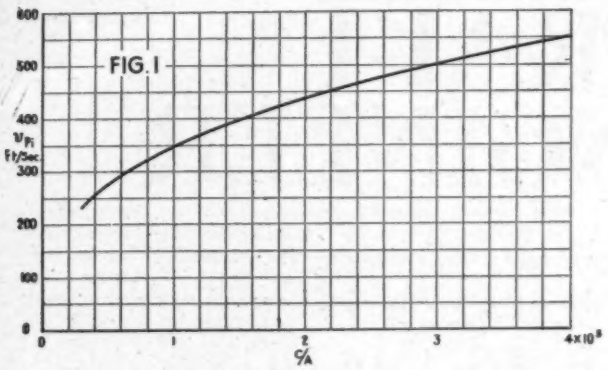
Rearranging, and substituting for equation (3) we get:

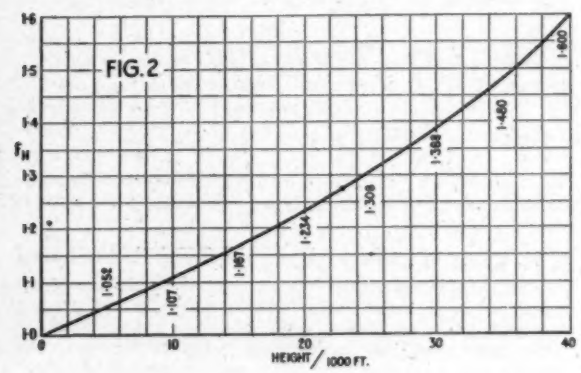
$$\Delta v = \frac{B}{3\rho C} + (\Delta v)^2\left[\frac{A\rho}{C}\right]^{1/3}$$

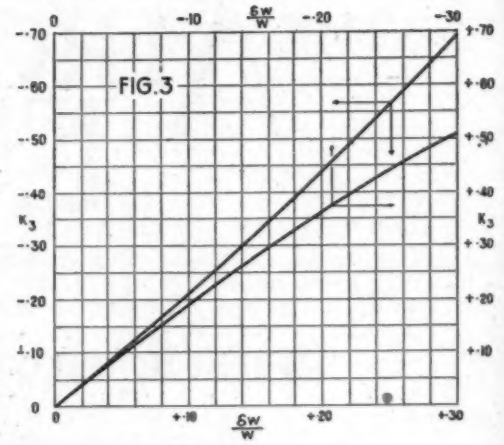
The second term is always very small compared with the first, and may therefore be neglected.

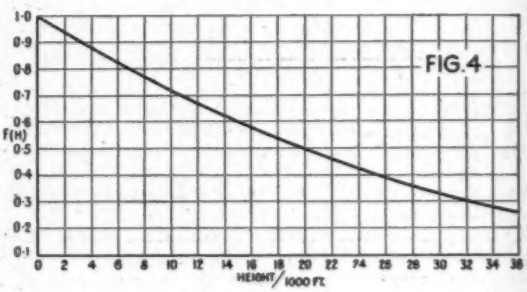
We thus arrive at the very simple result that the decrement of speed due to the induced drag is given by:

$$\Delta v = \frac{B}{3\rho C} \quad .. \quad .. \quad .. \quad (4)$$









When the value of Δv thus determined is large, say above 15ft./sec., it is in error on the optimistic side. A good second approximation in this case is obtained as follows:

Take the true value of Δv as:

$$\left[\frac{v_p}{v'}\right]^2 \cdot \Delta v \quad .. \quad .. \quad .. \quad (5)$$

giving $$v' \text{ true} = v_p - \left[\frac{v_p}{v'}\right]^2 \cdot \Delta v$$

(This process is more or less empirical, though there is some theoretical basis for it, which need not be given here.)

The method of determining the level flight speed for any given conditions is therefore:

(*a*) From Fig. 1, which is a plot of $\left[\frac{C}{A\rho_0}\right]^{1/3}$ against C/A, find the value of v_{pi} for the given value of C/A.

(*b*) From Fig. 2, which is a plot of $\left[\frac{\rho_0}{\rho}\right]^{1/3}$ against height in the Standard Atmosphere (Ref. 1), find the value of f_H for the height in question.

(*c*) Multiply v_{pi} by f_H, giving v_p

(*d*) Calculate the value of $\frac{B}{3\rho C}$ and subtract it from v_p, and apply the second approximation if necessary.

The result is the true level flight speed, v'

The example at the end of these notes demonstrates the practical simplicity of the method.

It is interesting to note that the percentage change in induced drag (and, in view of expression (4), the percentage change in Δv) per unit change in aspect ratio decreases as the aspect ratio increases and *vice versa*.

Recapitulating:

$$B = \frac{2}{\pi}\left(\frac{W}{b}\right)^2 K_1$$

$$= \frac{2}{\pi} W^2 K_1 \left(\frac{1}{b}\right)^2$$

Now Aspect Ratio (A.R.) $= \frac{b^2}{S_W}$

or $$\left(\frac{1}{b}\right)^2 = \frac{1}{(\text{A.R.}) \times S_W}$$

That is to say, for a given wing area B is inversely proportional to aspect ratio. The following table will clarify these remarks:

A.R.	5.0	6.0	7.0	8.0	9.0	10.0
$\left(\frac{1}{b}\right)^2$	$\frac{.200}{S_W}$	$\frac{.167}{S_W}$	$\frac{.143}{S_W}$	$\frac{.125}{S_W}$	$\frac{.111}{S_W}$	$\frac{.100}{S_W}$
Factor on B and Δv (A.R. = 7.0 as standard) ..	1.400	1.167	1.000	0.875	0.778	0.701
Difference % ..	/	23.3	16.7	12.5	9.7	7.7	/

(In practice this effect would be magnified by the rapid increase of wing weight with aspect ratio.)

The above method of allowing for the effect of induced drag lends itself to a simple tabulation for estimating the fuel required for a specified range at constant B.H.P.

If the airscrew efficiency be assumed constant throughout the range (which is probably very nearly true), equation (4) may be written:—

$$\Delta v = K_2 \left[\frac{W}{100}\right]^2$$

where

$$K_2 = \frac{3.86 K_1}{\rho \eta \text{ B.H.P.} b^2}$$

The method is a step-by-step one, and is most easily explained by giving an example, as is done in the table, for a fictitious aeroplane. The various columns are as follows (see next page):—

1. In row 1 the weight of the machine without any fuel (or bombs, if relevant) is written, and in

FUEL REQUIRED FOR RANGE AT CONSTANT B.H.P.

Total B.H.P. = 4 × 1,000 = 4,000
Weight, less fuel or bombs = W_0 = 45,000 lbs.
Weight of bombs (W_B) = 5,000 lbs.
Required range = 2,500 miles.
Bombs dropped after 1,250 miles.

Fuel consumption = $\frac{.50}{8} \times 4{,}000$ = 250 galls./hr.
= 250 × 7.5 = 1,875 lbs./hr.

$$D_T = 19.0\,\rho v^2 + \frac{W^2}{19{,}000\,\rho v^2}$$

C = .82 × 550 × 4,000 = 1,804,000
C/A = 1,804,000/19.0 = 94,950
vpi = 342 H = 15,000′ ρ = .001496 f_H = 1.167 vp = 399 K_1 = 1.0
$K_2 = K_1 \times 3.86/\rho \,.\, \eta \,.\, BHP \,.\, b^2 = 1.0 \times 3.86/.001496 \times .82 \times 4{,}000 \times 110^2 = .000065$

(1) $W = W_0 + \Delta W_F (+ W_B)$	(2) $\left(\frac{W}{100}\right)^2$	(3) (2.) × K_2	(4) (3.) Corr.	(5) $v = vp - (4.)$	(6) V	(7) $\Delta R/(6.) = \Delta t$	(8) $\Delta W_F = 1.875 \times (7.)$
45,000	202,500	13.2	14	385	262	$\frac{500}{262} = 1.908$	3,580
48,580	236,010	15.3	17	382	260	$\frac{500}{260} = 1.923$	3,610
52,190	272,370	17.7	20	379	258	$\frac{250}{258} = .969$	1,820
59,010 W_B	348,220	22.6	26	373	254	$\frac{250}{254} = .984$	1,850
60,860	370,390	24.1	27	372	254	$\frac{500}{254} = 1.969$	3,690
64,550	416,680	27.1	31	368	251	$\frac{500}{251} = 1.992$	3,740

From Σ (8), total fuel required for range = 18,290 lbs. = 2,440 galls.

other rows the sum of columns 1 and 8 (of the previous row) and at the appropriate stage, the weight of the bombs is also added.

2. Is column 1 divided by (100)²
3. Is K_2 × column 2.
4. Is column 2 corrected according to equation (5).
5. Is v_p minus column 4.
6. Is column 5 in m.p.h.
7. Is Δ R divided by column 6.
8. Is column 7 × the fuel consumption in lb./hr.

It is useful in preliminary design to be able to express the percentage change in speed, due to a change in parasite drag or weight, as a multiple of the percentage change in parasite drag or weight. We will now develop formulae for this purpose.

The Effect of Changes in Parasite Drag and Weight on Level Flight Speed

Re-arranging equation (2) gives :—

$$A = \frac{-B}{(\rho v^2)^2} + \frac{C}{\rho v^2}$$

Differentiating with respect to v and taking the reciprocal gives :—

$$\frac{dv}{dA} = \frac{(\rho v^2)^2\, v}{4B - 3C\rho v}$$

For small values of δv, after re-arrangement this becomes :—

$$\frac{\delta v}{v} = \frac{\delta A}{A}\left[\frac{1}{(D_i/D_p) - 3}\right]_v \quad .. \quad .. \quad .. \quad .. \quad (6)$$

where D_p, D_i and T are the parasite drag, induced drag and thrust respectively at the original speed v.

This expression therefore gives the fractional change in speed in terms of the fractional change in A, and the conditions at the original speed.

Again re-arranging equation (2) :—

$$B = C\rho v - A(\rho v^2)^2$$

Differentiating with respect to v and taking the reciprocal gives :—

$$\frac{dv}{dB} = \frac{1}{\rho v\,(T - 4D_p)}$$

Now

$$\frac{dB}{dW} = \frac{4}{v} \cdot \frac{W}{b^2}$$

hence

$$\frac{dv}{dW} = \frac{4\ W}{\pi b^2 \rho v (T - 4D_p)}$$

For small values of δv, after re-arrangement this becomes :—

$$\frac{\delta v}{v} = \frac{\delta W}{W}\left[\frac{2}{1 - 3\,(D_p/D_i)}\right]_v \quad .. \quad .. \quad .. \quad (7)$$

This expression therefore gives the fractional change in speed in terms of the fractional change in weight and the conditions at the original speed.

From equations (6) and (7) the condition for simultaneous changes in A and W, without change in speed may be obtained. The condition is that

δv (Eqn. 6) = $-\delta v$ (Eqn. 7)

and this comes out as :—

$$\frac{\delta A}{A} = -\frac{\delta W}{W}\left[\frac{2D_i}{D_p}\right]_v$$

The constant 2 is actually found to be a function of $\frac{\delta W}{W}$, so that the final expression is :—

$$\frac{\delta A}{A} = K_2\left[\frac{D_i}{D_p}\right] \quad .. \quad .. \quad .. \quad .. \quad .. \quad (8)$$

where K_2 is given by Fig. 3.

This expression therefore gives the relation between the fractional changes in A and W in terms of the drags at the original (and maintained) speed, under the original conditions.

The expressions for minimum drag and power required, with their associated speeds, can also be obtained from consideration of equation (1).

Since :—

$$D_T = A\rho v^2 + \frac{B}{\rho v^2} \quad .. \quad .. \quad .. \quad .. \quad (1)$$

by differentiation we get :—

$$\frac{d(D_T)}{dv} = 2A\rho v - \frac{2B}{\rho v^3}$$

For minimum drag this is zero, giving :—

$$\rho v^2 = \sqrt{B/A} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (9)$$

thus defining the speed for minimum drag. Substitution in equation (1) gives :—

$$D_T \text{ min.} = 2\sqrt{AB} \quad .. \quad .. \quad .. \quad .. \quad (10)$$

(Under these conditions the induced and parasite drag are, of course, equal).

In a similar manner the speed for minimum power required is defined as :—

$$\rho v^2 = \sqrt{B/3A} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (11)$$

and :—

$$P_r \text{ min.} = \frac{.00319}{\rho^{\frac{1}{2}}} \cdot \sqrt{B} \cdot \left(AB\right)^{\frac{1}{4}} \sqrt{B} \cdot \left(AB\right)^{\frac{1}{4}} \quad .. \quad (12)$$

Equation (12) can be adapted to give a simple method of rapidly estimating the absolute ceiling of an aeroplane, which will demonstrate clearly the adverse effect of a high span loading on this performance characteristic.

Estimation of the Absolute Ceiling

It is assumed that the speed of flight at the absolute ceiling is that for minimum power required, and from Equation (12) :—

$$P_r \text{ min.} = \frac{.00319}{\rho^{\frac{1}{2}}} \sqrt{B} \left(AB\right)^{\frac{1}{4}}$$

This reduces to :—

$$P_r \text{ min.} = \frac{.0466}{\sigma^{\frac{1}{2}}} \left(\frac{W}{b}\right)^{\frac{3}{2}} A^{\frac{1}{2}} K_1^{\frac{3}{2}} \quad .. \quad .. \quad .. \quad (13)$$

This relationship is plotted in Fig. 5, and the right-hand side of the equation may be evaluated with the help of that Fig. The adverse effect of a high span-loading on the absolute ceiling is seen very clearly from this formula, and at the same time the relatively small importance of the parasite drag.

Examples of the Use of the Formulae Developed

These examples will show the simplicity of the use of the formulae, and also the degree of accuracy obtained.

Consider the aeroplane quoted in Table "Fuel Required for Range at constant B.H.P." flying at top speed at 13,500ft. on (say) 4 × 1,500 B.H.P., at an all-up weight of 50,000 lb.

Then :—

$$C = 4 \times 1{,}500 \times 550 \times 0.84 \text{ (say)} = 2{,}772{,}000$$

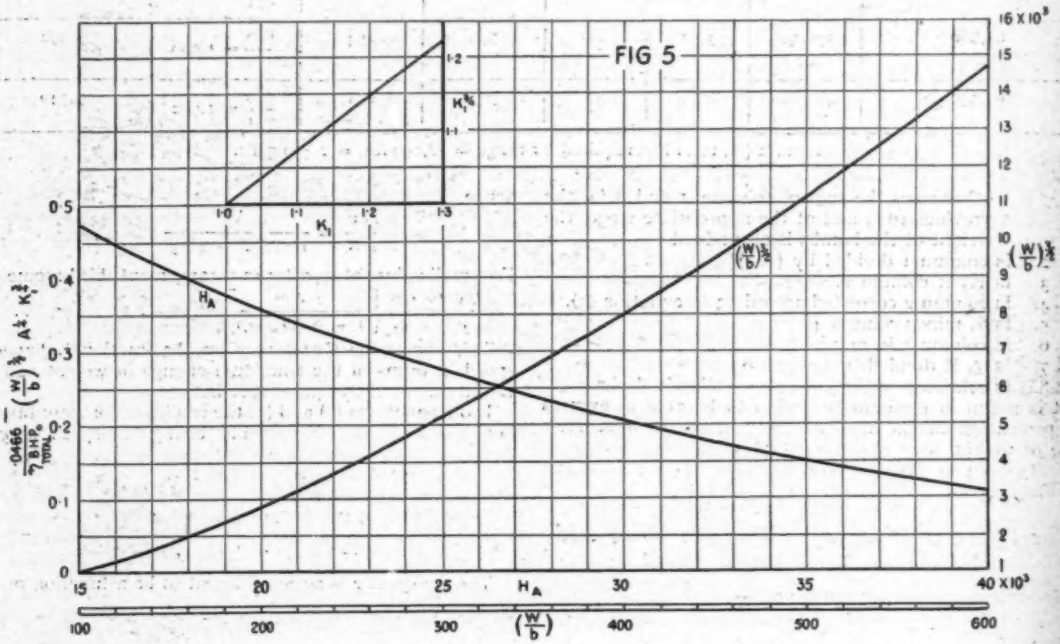
$$C/A = 2{,}772{,}000/19.0 = 145{,}900$$

From Fig. 1 $v_{pi} = 395$

From Fig. 2 $f_H = 1.150$

Then :—

$$v_p (= v_{pi} \times f_H) = 395 \times 1.150 = \underline{454 \text{ ft./sec.}}$$



Now, in the Standard Atmosphere, up to an altitude of 35,000ft., the relative density (σ) is given by :—

$$\sigma = \left[1 - .00688 \left(\frac{H}{10^3}\right)\right]^{5.256} \quad .. \quad .. \quad .. \quad (14)$$

The BHP at any altitude can be taken as :—

$$BHP = BHP_0 (\sigma)^{1.118} \quad .. \quad .. \quad .. \quad .. \quad (15)$$

where BHP_0 is a fictitious sea level power, obtained by dividing the BHP at the rated altitude by the value of $f(H)$ at that altitude; this may be read from Fig. 4, which is a plot of $\sigma^{1.118}$ against height in the Standard Atmosphere, and is the ratio of the BHP at any height to the BHP at sea-level for un-supercharged engines.

Now :—

$$P_r \text{ min.} = \eta BHP. \text{ (Total)}$$

Hence, substituting for equation (14) in equations (13) and (15), we get :—

$$\eta BHP_{0\,(\text{Total})} \left[1 - .00688 \left(\frac{H}{10^3}\right)\right]^{5.256} = .0466 \left(\frac{W}{b}\right)^{\frac{3}{2}} A^{\frac{1}{2}} K_1^{\frac{3}{2}}$$

or :—

$$\left[1 - .00688 \left(\frac{H}{10^3}\right)\right]^{5.256} = \frac{.0466}{\eta BHP_{0\,(\text{Total})}} \left(\frac{W}{b}\right)^{\frac{3}{2}} A^{\frac{1}{2}} K_1^{\frac{3}{2}}$$

Now :—

$$B = \frac{2}{\pi} \left(\frac{50{,}000}{110}\right)^2 \times 1.1 \text{ (say)} = 227{,}250$$

ρ at 13,500ft. = 0.001570

Hence :—

$$\frac{B}{3\rho C} = \Delta v = \frac{227{,}250}{3 \times .00157 \times 2{,}772{,}000} = \underline{17.4 \text{ ft./sec.}}$$

Applying the second approximation :—

$$\Delta v_{\text{true}} = \left(\frac{454}{454 - 17.4}\right)^2 \times 17.4 = 18.82 \text{ ft./sec.}$$

$$= \underline{19 \text{ ft./sec. (say)}}$$

Thus :—

$$v = (454 - 19) \text{ ft./sec.} = \underline{435 \text{ ft./sec.}}$$

Since Total Drag = Thrust, this may be checked thus :

v	ρv^2	19.0 ρv^2	$\frac{227{,}250}{\rho v^2}$	D_T	$\frac{2{,}772{,}000}{v}$	ΔT
435	297.1	5,645	765	6,410	6,372	− 38
Try						
434	295.7	5,619	769	6,388	6,388	—

The error is thus seen to be 1 ft./sec., or less than 1 m.p.h.

(*Continued on p. 294*)